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## TELESCOPIC RESEARCH ON THE NEBULA OF ORION.

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IT is well occasionally to cast our eyes back over a series of labors, in order that we may rightly judge of our progress.

Rough comparisons alone will not tell us: it is easy to contrast Galileo's piece of lead-tubing, having a lens in each end of it, with the gigantic telescopes of to-day; but we hardly learn much from such a comparison. The extremes of the series are too far removed; to get a just idea of the terms between, the comparisons must be made at shorter intervals.

If we can select some celestial object, which has been telescopically studied for a long period, we may, by contrasting the results obtained at different times, gain some accurate notion of the progress made, and of the way in which it was made.

This latter idea is of some importance when we consider that the day of startling discoveries is over. When Galileo found the four moons of Jupiter, the whole world of men of learning was astounded; and still more wonderful was his discovery of the ring of Saturn—that is to say, of the existence of a ring of Saturn—a portion of which, showing on each side of the planet, gave to Saturn the "tricorporate" aspect which Galileo describes in a letter to his friend Kepler.

Even the discovery of Uranus by Sir William Herschel, in 1789, was by no means an extraordinary event, although it was received with enthusiasm in all Europe, for Herschel's examination of the heavens was done with the aid of an instrument which could not fail to show Uranus with a sensible disk, if the planet should enter the field of his telescope.

The discovery of the first asteroid, Ceres, on the 1st day of January, 1801, by Piazzi, was received with some surprise, but these small bodies have lately become quite common (there being now 135

of them known), and certainly we in America, who have Peters and Watson among us, have no cause to wonder at such discoveries.

Neptune was discovered first by two theoretical astronomers in their studies, and the delight with which the news of the actual discovery was received was a tribute to the power of pure analysis, and in nowise contributed to the glory of telescopic research.

The startling discoveries, as we have seen, were reserved for the early astronomers, who first found the new country, leaving their successors to accurately map it out. The lesson of patience which can be learned from the labors of these successors is no mean one. To this patience, supplemented by a skill which usually must be of a high order, we owe the later discoveries of the telescope, such as the finding of the eighth satellite of Saturn (by Bond and Lassell), and of the two interior moons of Uranus (Lassell, 1847 and 1851), and of the satellite of Neptune.

There is hardly an object in the whole heavens—planets, of course, excepted—which has been so thoroughly and faithfully studied as the Great Nebula in Orion. And this nebula has a history which will well repay a study somewhat in detail. We shall, in comparing the different work already done upon it, arrive at a very good idea of the progress of telescopic astronomy itself, since, for over 200 years, the details of this nebula have been a subject of solicitude to a great number of eminently skillful astronomers, aided by the best telescopes of their time.

The nebula was discovered by Huyghens in 1656, and in our own century it has been studied by the great reflectors of Herschel and Rosse, and by the refractors of Cambridge, Pulkova, and Rome, in the hands of Bond, Struve, and Secchi.

The place of this nebula in the heavens is easily to be found by any one tolerably familiar with the aspect of our winter sky.

The constellation of Orion is a well-known and brilliant asterism, and very conspicuous among the other stars of the group are the three stars which constitute the "belt." Below these are three others, in nearly a straight line, and these are known as "the sword:" the northern star of these is C Orionis; the middle one is $\theta$ (Theta) Orionis; and the southern is $\iota$ (Iota) Orionis; it is of the nebula surrounding $\theta$ Orionis that we wish to speak.

Flamsteed, astronomer-royal of England, marked $\theta$ Orionis in his catalogue of stars, as of the fourth magnitude, and to the naked eye it so appears.

But, on examination with a telescope, this star is seen to be not single, but multiple. When Huyghens, in 1656, turned his newly-constructed telescope to it, he saw *three* stars, and these were surrounded by a cloud-like mass—the nebula.

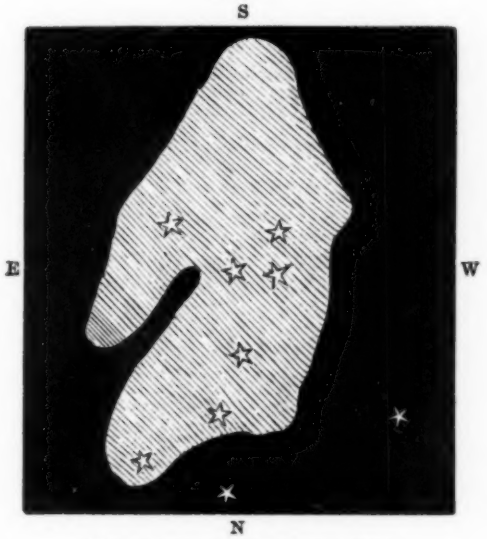
The figure which he printed in his "Systema Saturnium" is given (Fig. 1, p. 259), together with the figure of the French astronomer,

Le Gentil, which was drawn in 1758, and which may be found in "Histoire de l'Académie," 1759. This is Fig. 2.

The fourth star was, however, seen by Domenique Cassini before Le Gentil's drawing was made.

Not a little is to be learned from these figures, which we must try to keep in mind, as the region to which they refer is the central and most interesting portion of the great nebula. We can see, first, that

FIG. 1.




NEBULA ORIONIS. (Huyghens, 1656.)

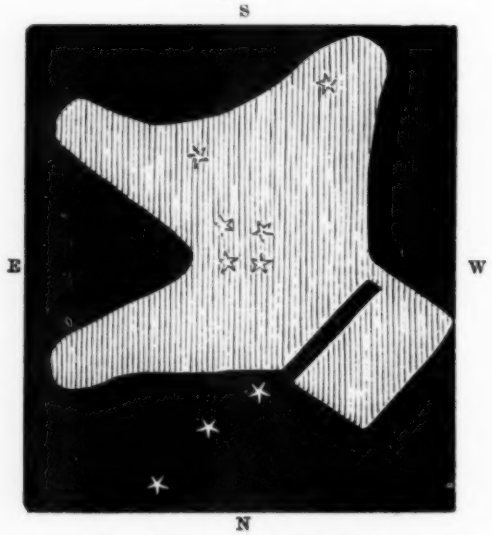
there is an entire absence of shading in the portion of the nebula drawn; the outline of nebulous matter is simply filled in by shading of a uniform tint. It is much to be regretted that it is impossible to print here the exquisite engraving of this nebula, made from drawings by Prof. G. P. Bond, director of Harvard College Observatory, in 1865. In this drawing one hardly knows which to admire most, the accuracy and painstaking skill of the astronomer, or the exquisite tact of the engraver. There are very few nights so fine, and there are very few instruments so perfect, as to give a view of this nebula as good and as detailed as may be had from this engraving alone.

But we must be content with referring to the plate ("Annals of Harvard College Observatory," vol. v.) for the details of the *nebulous* portions of this region, and we must content ourselves with reproducing only the stars of the surrounding space. It is true that especial attention has been paid by some astronomers to the smaller stars in this nebula; while some, as Herschel the younger, have evidently bestowed more care upon the grades of light in the nebula itself; but,

on the whole, we shall find that the number and faintness of the small stars, seen by any astronomer in any one limited region, are a very fair test of his own assiduity, and of the excellence of his telescope.

It will be seen that Le Gentil has made of the star $\theta$ Orionis *four* stars, adding one to the number seen by Huyghens. These four are the celebrated trapezium of Orion, and they constitute one of the most remarkable multiple stars of the whole heavens.

FIG. 2.




NEBULA ORIONIS. (Le Gentil, 1758.)

Messier, who examined the nebula carefully, in 1771, gives these four stars, and a very good drawing of the nebula, in "Histoire de l'Académie," 1771. This work was extremely creditable, considering his instrumental means, and the comparatively short time spent upon it.

This trapezium was destined to become famous, for, in 1826, the elder Struve found, close to one of the large stars of the trapezium, a small companion—the "fifth star." This was for a long time considered as a delicate test for an instrument; but, in December, 1832, Herschel found yet another small star—the "sixth star." The trapezium now was seen (with suitable means) as in Fig. 3.

Let us follow the history of the whole nebula for a time, and we shall see what additions have been made to our knowledge of the space near this remarkable group.

It may be here remarked that the grouping of these six stars is in all probability not accidental, but that they are physically connected: Struve has shown that the chances are 9,000 to one against any two

stars from the first to the seventh magnitude, inclusive, falling within 4″ of each other if the stars were fortuitously scattered over the whole heavens to begin with. And, further, he has shown that the chances are 170,000 to one against any such stars, if fortuitously scattered, falling within 32″ of a third so as to form a triple star. The chances against any such grouping as that seen in the trapezium of Orion are enormously greater than the numbers given above, and the inference is irresistible that these stars are in some way physically connected. We shall see, too, that it is also probable that these stars are in some unknown way related to the surrounding nebula.

FIG. 3.

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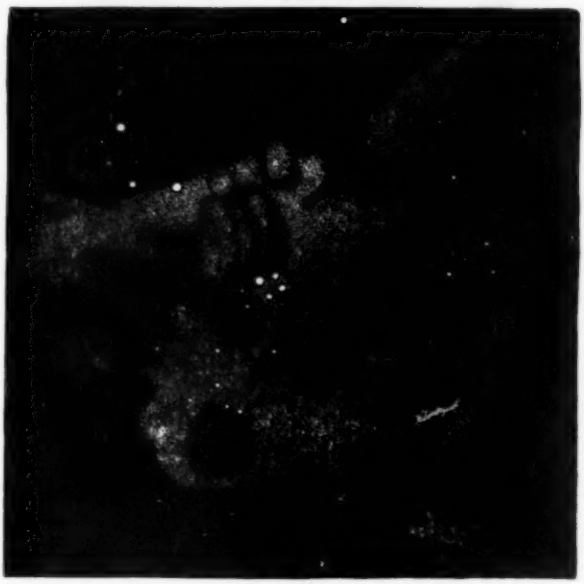


N

CENTRAL AND MOST BRILLIANT PORTION OF THE GREAT NEBULA IN THE SWORD-HANDLE OF ORION, AS OBSERVED BY SIR JOHN HERSCHEL IN HIS 20-FOOT REFLECTOR AT FELDHAUSEN, CAPE OF GOOD HOPE (1834 TO 1837).

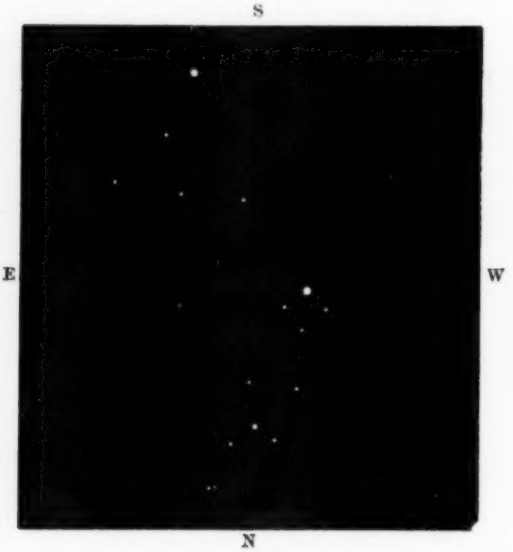
In 1811 Sir William Herschel was led to suspect changes in the form and brightness itself: an inference which he probably drew from a comparison of the early drawings with the appearance of the nebula as he saw it in his own reflectors; and in 1824 the younger Herschel made a drawing of the nebula and the stars immersed in it, as shown by his 20-foot reflector.

This drawing and a description of the nebula are given in "Memoirs of the Royal Astronomical Society," vol. ii., p. 489, and a copy of the drawing, so far as the small stars immediately about the trapezium are concerned, is given in Fig. 4.

The recession of the nebula from the stars of the trapezium is here

noted for the first time, so far as I know: this recession is a real phenomenon, and is thus spoken of by Sir John Herschel: "The nebula, which is very bright in the parts surrounding the trapezium, seems (whether by the effect of contrast with the dazzling light of these stars, or from a real deficiency in nebulous matter) to have retreated from immediate contact with them, so that they appear in some degree insulated and with a darkness about them. This would agree with the idea of a subsidence of the nebula into the stars by gravitation; but it is probably only a deception."

FIG. 4.




NEBULA ORIONIS. (Herschel, 1824.)

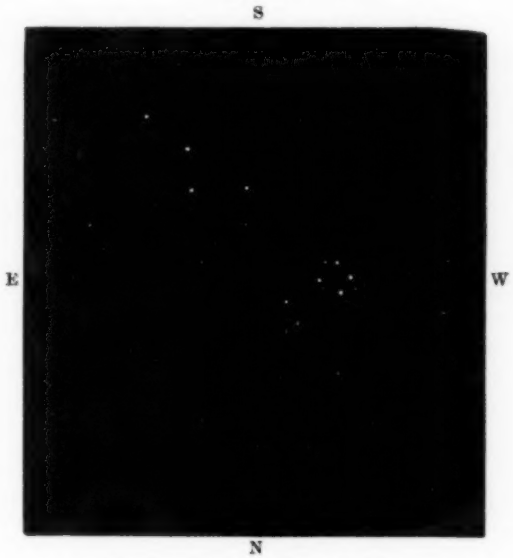
Sir John likewise expresses an opinion as to the resolvability of the nebula, and describes its appearance in a very graphic way. He says: "I know not how to describe it better than by comparing it to a curdling liquid, or to a surface strewed over with flocks of wool, or to the breaking up of a mackerel sky when the clouds of which it consists begin to assume a cirrous appearance. . . . "It presents, however, "no appearance of being composed of small stars, and its aspect is altogether different from that of *resolvable nebulæ*. In the latter we fancy by glimpses that we see stars, or that, could we strain our sight a little more, we should see them. But the nebula suggests no idea of stars, but rather of something quite distinct from them."

In the beginning of 1834 Sir John Herschel went to the Cape of Good Hope for the purpose of completing a survey of the whole heavens, which had been commenced in England: he took with him his 20-foot reflector (aperture 18¼ inches), and devoted himself during

his stay there to astronomical work. The nebula of Orion of course attracted much of his attention, and on account of its favorable situation for observation he was enabled to examine it to much better advantage than in England. In the "Astronomical Observations at the Cape of Good Hope," Herschel has given a figure of the nebula as he saw it (see Fig. 3), and has added an account of its appearance, a portion of which account we shall quote.

Fig. 5 is a representation of the small stars immediately in the vicinity of the trapezium as seen by Herschel.

FIG. 5.




NEBULA ORIONIS. (Herschel, 1834.)

It is easily seen that the circumstances at the Cape of Good Hope were much more favorable than they had been in England: this is witnessed in the figures here given by the greater number of stars shown, and in the original drawing by the amount of detail in the features of the nebula itself. The nebulosity surrounding $\theta$ Orionis was traced by Herschel over half a square degree of space, and numerous points of doubt were settled. In his account Herschel states that he discovered the sixth star of the trapezium in 1832, and he expresses his surprise that Struve, who had examined the stars in this neighborhood frequently, should have overlooked it.

Da Vico, of the Roman College, had in 1839 declared that he had seen the stars *within* the trapezium (an assertion which has been repeated since by various observers, good and bad), and Herschel takes the opportunity to declare that not only had he seen no stars there, but that the absence of any trace of star or even of nebulosity

was one of its most striking features. (Herschel's remarks in this regard are fully confirmed by the best observers.)

But, as we may see by a reference to Fig. 5, Herschel had discovered quite a number of small stars, some of them extremely faint and difficult, notably one marked 78 in the figure (No. 78 of Herschel's Catalogue).

Later researches on the stars in this group have added largely to their number, but hardly any have been found more faint than this star H. 78.

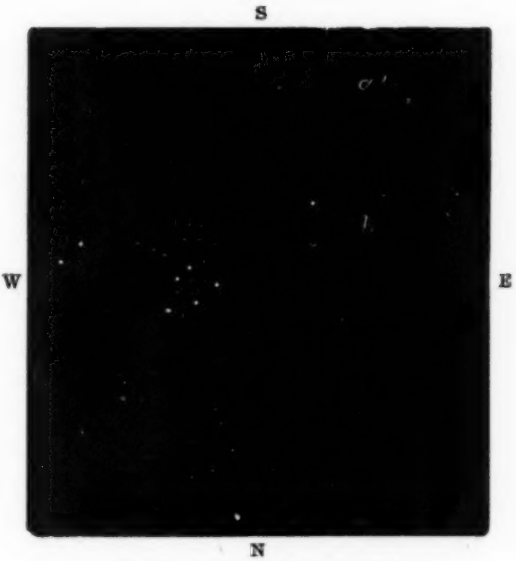
Bond, of Cambridge, and O. Struve, of Pulkova, with the fifteen-inch refractors of those observatories, both observed it and found it extremely difficult, and both of these observers supposed it to be variable in magnitude. It seems almost impossible that Herschel should have seen H. 78 and that he should *not* have seen others seen by both Bond and Struve, if the star was as faint in 1834 as it is in 1874; and the inference seems hard to avoid, that this very faint star was perceptibly brighter in 1834 than at present.

Herschel discusses the evidences of change in the nebula at some length, and, although his own drawings of 1824 and 1837 differ as much as any two drawings which we have, he is strongly of belief that these differences, although great, "are not more so than I am disposed to attribute to inexperience in such delineations," and to various other causes, such as the favorable situation of the nebula in the southern sky, etc. One part of the nebula he does regard as probably variable, and, to prove this, he compares his two drawings. It may be said that, so far as our knowledge now goes, this suspicion of Herschel's is not confirmed.

In 1852, Mr. Lassell, already famous as the discoverer of various satellites of the major planets, took his magnificent twenty-foot reflector to Valetta, to use it to good advantage in the serene atmosphere there. While his telescope was mounted at Valetta, Mr. Lassell made careful observations of the Orion nebula, and he even had a painting in oil made from his own drawings, and from the nebula itself, by an artist-friend. When we consider the immense difficulty of drawing even the *form* of so complex an object as this is at the telescope, from which the eye must be removed every moment to add a new line, or to verify one already drawn, and when we further consider what added pains must be taken in order to get an approach to accuracy of light and shade, we must admit that the attempt to represent not only form, and light and dark, but also color and tint, is almost a vain one. Accordingly, we find Mr. Lassell's drawing of the nebula itself to be strikingly different from Herschel's or Rosse's (made in 1867), but we ought not on that account assume any change in the nebula itself. Any one who has made such drawings will know what strong and direct evidence of change must be had to establish it as a fact.

Mr. Lassell's drawing (Fig. 6) exhibits the same characteristics as Herschel's in one respect. He has noted some very faint stars, particularly one, of which we will speak further, but he has omitted others much brighter (at least, brighter in 1874, and also brighter when mapped by Bond in 1865). We must attribute this to a desire to depict the form of the nebula itself, and a neglect of the stars in comparison; and yet this is difficult to do, since Lassell has given us a map of new stars which he found, some of which have never been seen by any observer since, and presumably do not exist, or have vanished. Lassell, again, finds no trace of resolvability in this nebula.

FIG. 6.




NEBULA ORIONIS. (Lassell, 1852.)

It will be noticed that Lassell has a large number of small stars above and to the left of the trapezium. These are put in the map by eye-estimates of their position, and it is somewhat difficult to identify them with Bond's stars in this place, but I have no doubt that all of them are real. Lassell's *b* and *g* have never been seen by any later observer, and probably they do not exist. *a'* of Lassell's map was not even noted by him as a new discovery, but it remained unseen even by the keen vision of Bond and Struve, until the mounting of the great Alvan Clark refractor (18½ inches aperture) in 1862, when Alvan Clark, Jr., found this star by the aid of that instrument.

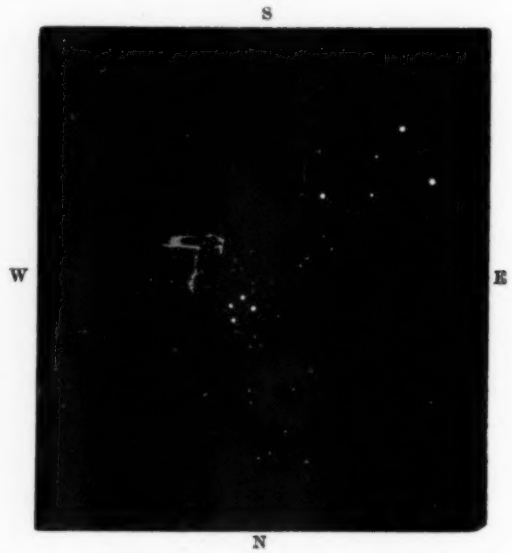
His observation has been verified by the great Clark refractor, at Washington (26 inches aperture).

In 1848, Mr. W. C. Bond, Director of Harvard College Observatory, made, by the aid of the 15-inch refractor, a map and a drawing

of the nebula and its contained stars. There was a large number of errors in this catalogue, and Bond's work was sharply criticised by O. Struve, whose "Memoir on the Nebula of Orion" appeared in 1862. Struve's work, which was a revision and an extension of the work of Liapanoff (done at Kazan with a 9-inch refractor), was executed very carefully with the 15-inch telescope of Pulkova; and some of his strictures on the elder Bond's work were so severe as to induce G. P. Bond, his son, then Director of Harvard College Observatory, to take up his father's work, to complete and amend it. This he has done in a most admirable monograph, which is a model of its kind. We have already spoken of his engraving of the nebula, and its excellence is only commensurate with the completeness of the whole of the memoir.

Fig. 7 represents the small stars in the now familiar ground near the trapezium.

FIG. 7.




NEBULA ORIONIS. (G. P. Bond, 1865.)

It will be seen how much fuller this map is than Lassell's, which contains more small stars probably than any of the preceding ones.

Lord Rosse's great reflecting telescope of 6-feet aperture was employed at various times, between 1848 and 1867, in making drawings of the Orion nebula; and we have, as the results of the work, two great engravings, upon which much care has been spent.

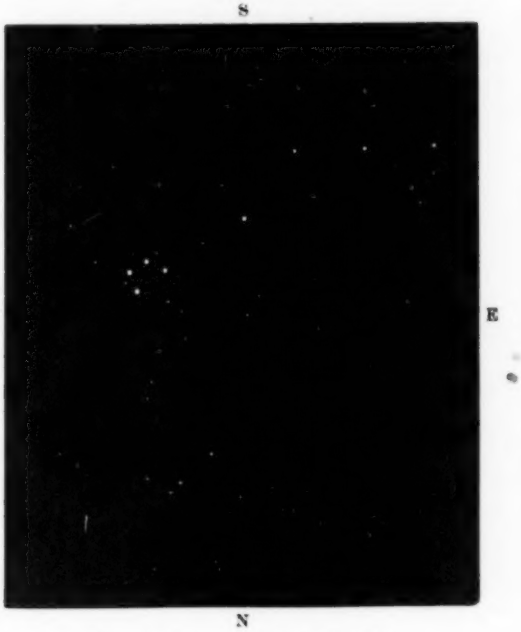
These certainly differ in many important points from the preceding drawings which were made by reflectors (and experience will show us that it is not easy, critically, to compare drawings made by reflectors and by refractors); but this is simply a proof that the drawings of dif-

ferent instruments are hardly comparable. Indeed, drawings by different observers, with the same instrument, and made at the same time, are often as different from each other as any of the previous drawings from Lord Rosse's.

The resolvability of the nebula is claimed by Lord Rosse, but the testimony of the spectroscope, as far as that goes, is against that inference, and the testimony of large telescopes, at least equal to Lord Rosse's in their defining power, is likewise unanimously contrary.

Any one, who will critically study the drawings named above, will, it is believed, arrive at the conclusion that no traces of resolvability have been fairly made out. Changes of form, although the evidence of the various drawings is seemingly in favor of such changes, are not probable, from a comparison of all the data. The drawing of Bond is confirmed, we believe, by Safford, of Chicago, by aid of the 18½-inch refractor, and by the great refractor of the Naval Observatory at Washington, so far as an examination has been made, and

FIG. 8.




NEBULA ORIONIS. (ROSSE, 1860-'67.)

after a careful collation of all drawings; the only inference it seems possible now to draw is as to the enormous personal differences of the artists. It should be remembered that the difficulty of getting a correct drawing engraved correctly is itself immense, and not often to be overcome, especially if the engraver has not himself studied the nebula which he is to represent.

Fig. 8 is a part of Rosse's drawing made with the six-foot telescope.

It will be seen that the number of small stars above and west of the trapezium is very small, but a reference to the original drawing would show that the nebula was traced very far away from the central star: we see from these facts that the famous Rosse telescope is surpassed by several other telescopes in *definition*, but its enormous surface, when in good condition, is a great light-gatherer, and a faint nebulosity is distinguished in it more easily than in most other instruments—Lassell's reflector, for example.

Bond, however, has surpassed, by the aid of the 15-inch refractor at Cambridge, the work of Lord Rosse's assistants in every way, even in regard to the very points for which the reflector was best fitted. We must, however, attribute this, in no small degree, to the skill and assiduity of Bond himself.

We have thus traced the history of the nebula of Orion, as developed by the telescope alone, from its discovery to the present time. This has been done only imperfectly, on account of the impossibility of presenting complete engravings of the drawings made by the different observers, to whose work reference has been made. Several other astronomers of note have worked on this subject—notably Lamont and Secchi—but the results of their telescopic work are included in the preceding account.

The necessary conclusions as to the resolvability and change of the nebula have been indicated, as well as the strong probability that the nebula and the stars in the neighborhood are physically connected, which inference is mainly drawn from the recession of the nebula spoken of by Herschel.

The progress of telescopic research is well shown by the additions made year by year to our knowledge of this beautiful object, and we have no reason to be ashamed of it. The spectroscope has been busy on this nebula, as with others; but of its work it is not our purpose to speak. The desideratum in the study of these faint objects seems to be the extension of photography to their delineation. Until that is accomplished, we may rest content with such work as Bond and Struve have left us.[1]

[1] It is understood that a drawing of the Orion Nebula is soon to be published, unde the direction of Prof. Winlock, the present Director of Harvard College Observatory This is to be executed by Mr. Trouvelot, to whom we already owe many beautiful draw ings of celestial objects, published under the auspices of the Harvard College Obser vatory.

# THE GENESIS OF WOMAN.

By ELY VAN DE WARKER, M. D.

IN the construction of a piece of delicate mechanism there are two crises. Through some fault in its construction it may not permit movement in any part; and, each part being perfect, yet, through some defect in the arrangement, it may be capable of motion, but unable to fulfill the purpose for which it was designed. The first is an error of structure, the last an error of function.

If in the construction of the machine these sources of failure were avoided, it would perform its appointed office, until interrupted by an accident, or the natural wear of the parts entails both errors of structure and function.

At birth in the human animal sex is as distinct as at any after-period of life. Birth merely marks a stage of development, and not a change in design. Fœtal life to the perfection of the sexual design embraces simply a process of construction. This is the period in which the crises occur. By arrest of development, through imperfection in the structure of subsidiary parts, the perfection of function may never be reached. This would result from an error of structure. Structural perfection may be attained; but, through some defect in the mutual dependence of the parts, the perfection of sexual design may never be reached. This would result from functional error. The woman who has reached the stature and years which mark completion of structure, but in whom certain organs, vital to the attainment of sexual perfection, remain in an embryonic condition, or one who has reached anatomical perfection, but through defect of function may never gain that expression of sexual perfection called perfect ovulation, may be, in every other respect, physically a perfect woman, but has given a total defeat to the purpose for which she was designed. Both these errors are incidents in the genesis of woman. A fault of sexual function does not spring into existence the moment sexual life is to be crowned by ovulation. This imperfect function is a result, not a process. It antedates the commencement of ovarian life. It may be occult in the years of childhood, it may be antenatal, or even an error of ancestry. I believe it exists with the force of a law, that the conditions which result in ovarian irregularity are operative before and not during the establishment of that function. This office, like any other of the body, is exposed to the accidents of disease; but I think it may be proved that when irregularity of this function is the result of concurrent causes it is purely an accident—the exception which confirms the rule.

Young women become an object of parental or medical solicitude at a period when it will have but little influence on the perfection or

imperfection of their sexual life. By the keenness of the vision directed to this period of woman's genesis, they are blinded to all the years of formative childhood. Perfect function is an expression for perfect organs. Women do not reach the inception of ovarian life with organs in an infantile condition. During the years of childhood structural evolution goes on, and ends in the climax of function. It naturally follows, that during the period of structural development are sown the seeds of ovarian ill-health. For instance: given, a child with no inherited taint, reared as she ought to be, mentally, bodily, and hygienically, and who escapes the accidents incident to growth, and some time, between the years of thirteen and eighteen, she becomes functionally perfect, without trouble and without hazard, be she at the boarding-school, at college, or at home in the whirl of fashion.

As this subject is having a practical bearing upon the usefulness and higher education of young women at what is commonly regarded the critical period of their development, I deem it in the interest of a more perfect understanding of the matter, that it be studied in the light of recent physiology. It is apparent from the above, that instead of confining the critical period of woman's development to the establishment of ovarian function, I believe that the true crisis is confined to the formative years of childhood.

In stating my idea of the genesis of woman sexually, it will be necessary for me to keep in view the usually accepted belief, and to apply reasonable objections, based upon admitted physiological data, to the value assigned to puberty. It is at this period, when young women are entering upon their higher education, that it is claimed they are physically and mentally disabled from pursuing the same studies, in the same manner, and in the same institutions, with young men; and that their time and study must be arranged solely with reference to ovarian function. This is the latest medical opinion upon this question. The answer to this comes from a class of society, from men and women engaged in teaching the sexes, either separately or together. The answer is a flat denial, and has almost a flavor of poetic justice. It is couching the lance in defense of woman against the grave charge of periodicity. It is a matter to be regretted that those who have answered this content themselves with facts which have simply a negative value. It is evident that if ever a generally-accepted opinion upon this question is to be reached, it is attainable only by giving a just value, physiologically and hygienically, to the puberic age.

The position of writers upon the diseases of women, on this subject, is unfortunate, and one badly calculated to conserve public health. They comparatively ignore the formative years of childhood, or if referred to at all it is so incidentally that the interest turns upon the year of puberty. Dr. E. J. Tilt, of London, traces the diseases of ovulation to ovaritis, acute, subacute, and chronic. In his chain of

cause and effect he speaks of those only which lie at the very threshold of diseased action. Tracing back these morbid acts to their remote causes, he says a few words of those which we have all heard so much about—late hours and suppers, idle and luxurious habits, improper dress and exciting literature. I have no disposition to deny these conditions their just value in the cause of ovaritis. I acknowledge the importance of the diseases which he describes in the production of ovarian derangement. But, he speaks of the woman and ignores the child; the accidents of completion are all, and the accidents of formation nothing. There are causes of ovarian derangement other than those which are given by Dr. Tilt. Inflammation is not the only error of structure which may so result. There are conditions which must be assigned to the formative years of life. Relative excess or deficiency is one, and nervous action, radiating from the central or ganglionic systems, exerts a potent and unmeasured power for weal or woe upon ovarian periodicity. Dr. Tilt is not alone in assigning undue importance to the accidents of puberty. Dr. Meigs has had great influence upon the forming of opinion in this country, and his influence has been the more deeply felt from his having clothed with the graces of rhetoric some stern pathological facts. In describing the advent of puberty he has indulged in a sort of physiological antithesis. The child-life of woman is the material which is suddenly transformed into a being clothed in beauty, veiled in modesty, pulsating with charming passion and the divine consciousness of possible maternity. This is what the doctor says: "The earliest years of her life are occupied then in bringing her up to that point of perfect development of her alimentary, respiratory, innervative, and circulatory life, that may fit her for exerting the great reproductive force" ("Diseases of Women," p. 373); and "the transverse and antero-posterior diameters of the pelvis have suddenly and visibly increased" (p. 375); and "it seems as if the forces which had been employed to perfect the beautiful machine, by arranging and completing the quantitative synthesis of its organism, were now occupied, in a sort of paroxysmal intensity, with adorning it with all its graces and attractions, and setting upon it the seal of perfection" (p. 376); and, lastly, "this occurs between fourteen and fifteen years of age" (p. 372). This is certainly leaving a good many physiological facts unnoticed for the sake of dramatic unity. Leaving out the manner, the above is about the substance of what has been written by gynæcological writers upon this period of woman's life. Anatomical writers are also guilty of coming to hasty conclusions upon what ought to be regarded matters of fact rather than of opinion. Mr. Gray, in his "Anatomy," says, that "*about puberty* the pelvis in both sexes presents the general characters of the adult male pelvis, *but after* puberty it acquires the sexual characters peculiar to it in adult life" ("Anatomy, Descriptive and Surgical," p. 158).

In my first quotation, alimentation, respiration, innervation, and circulation, are spoken of, but no word of the development of sex, the very thing our author is writing about. Now, the normal evolutions of Nature, either physically or psychologically, are never paroxysmal. If the forces which direct development find expression in paroxysm, it constitutes disease and not health. It is almost impossible to conceive of a woman who is developed from a child in one year; and yet, this sudden transformation is generally regarded as a fact in the genesis of woman. In regard to the sudden increase of the pelvic diameters, I cannot but consider it as an "event viewed unequally," as the late Prof. Czermak said. I am not aware of the existence of any measurements of the pelves of children approaching puberic life which give the least color of evidence to this assertion. On the contrary, it is opposed to the common order of growth in plants and animals. The transverse and antero-posterior diameters of the cavity of the pelvis in the two sexes differ about one inch, roughly stated. If this difference is objected to as too great, there is still an admitted difference which would render such an increase of bone formation as a sudden development impossible. The opinion of Mr. Gray, that pelvic development is a post-puberic phenomenon, makes it necessary to explain some very absurd conclusions which legitimately follow. Such a condition would ascribe functions, which are the most perfect expressions for high structural development, to infantile organs. If there are those who still insist that Mr. Gray is right, they must admit the violation of a physiological law: that the organs within the pelvis have outgrown the capacity of the cavity containing them; that there exist adult organs in an infantile pelvis. Such a state of things in a healthy animal is impossible, if we accept the evidence of universal experience. The cavities of the cranium, the thorax, and the pelvis, have a steady and relatively equal development. In the accepted description of the sudden onset of ovarian life, and the equally rapid anatomical accommodation of the osseous and soft parts, mental changes are described as present which are as profound and important as those attending pelvic development. But it has never been thought necessary to describe any increase in cranial capacity to accommodate these objective mental phenomena. Even a new mental attribute is believed to be developed (Meigs), that of modesty, and it is therefore as reasonable to expect, to a limited extent, cranial as well as pelvic increase. Stated in this way—and it is a fair statement—it does not seem possible to accept Mr. Gray's opinion as an anatomical fact. Women do not necessarily cease to develop because of the establishment of the ovarian function. As a rule, women will increase in stature until the twenty-fifth year. It is an equable growth, a cementing, a binding together, and final completion. I regard this fact as evidence of the steady and gradual structural and functional evolution existent during the formative years of childhood, and prolonged into the child-

bearing era. Were changes of structure really as rapid at this period, it would imply vital depression, just as we see it in plants and animals taking on rapid growth, and just as we see impaired mental and bodily energy follow sudden and excessive exercise of any organ in a member of the human family. Yet at puberty the opposite occurs. Women are never so hopeful, buoyant, and strong, as at the beginning of healthy ovulation.

Analogy furnishes strong arguments in favor of the early and gradual preparation of the system generally for the ovarian function. Mammary enlargement antedates functional activity by months in cases of gestation. Here is a comparatively simple act, that of glandular secretion, preceded by elaborate structural preparation. In the sexual cycle of organs the mammæ act a subordinate part; yet in this region, in the two sexes during childhood, the first sexual characteristics may be detected in the well-developed. This is an interesting and most significant fact, and one that renders it highly improbable that pelvic enlargement is postponed to the puberic age, and coincides with many other facts which show that sexual evolution is a simultaneous movement toward completion by all the organs involved.

The commencement of the ovarian function is not the only crisis through which woman has to pass. There are two dentitions, each of which is a critical period. It is, I think, safe to say that the diseases incident to dentition destroy more human lives three to one than the diseases of ovarian function. Dentition is a process preceded by elaborate anatomical preparation, and furnishes the strongest analogous proof of gradual and persistent sexual development. Teeth which appear at the fifth to the sixth months of life, are preceded by anatomical changes begun as early as the sixth week of fœtal life. Teeth which are to make their appearance at the fifth to the ninth years of life are in a preparatory state at the seventh month after birth; and teeth which make their eruption between the seventeenth and twenty-first years are in a recognizable state of growth at the sixth year of age. Here is a most elaborate preparation for function, a slow and ceaseless building up, with—in a state of health—no paroxysmal outbreak, either in the growth or completion of function. It is equally true that the organs within the pelvis which characterize sex can be traced to a fœtal origin, and, during the months of infancy and years of childhood, they exhibit the same process of structural evolution. Paroxysm in the process of dentition is a disease, and it is equally a morbid act in the development of sexual maturity. Ovulation does not induce a greater change in the system and habits than does dentition. This may appear at the first glance to be an unwarranted assertion. But observe the change in the life and habits of the little human animal at the eruption of the deciduous teeth. After subsisting upon a single article of diet it becomes omnivorous: from entire dependence upon others, it has reached a certain amount of indepen-

dence, which entails a change in the mental character of the child. It instinctively exercises its new function of prehension, and is as prone to bite as a woman is to love.

And here let me recall what I said at the opening of this paper upon errors of structure. This process of dentition will illustrate it, and render its application to the diseases of ovarian function apparent. It is during the formative process of dentition that the function may be perverted, the shape and growth retarded. During this slow development it is at the mercy of faulty nutrition and hygiene. Perfect nutrition and ceaseless care are necessary to avert the dangers of dentition. The effort to ward off these disasters would be useless which confined itself to the completion of the act, to the neglect of the formative process. And yet this is the manner in which the sexual completion of woman is treated. How much we hear of the woman, and how little of the child!

Mental changes are described as taking place as suddenly as those of the body. There are of course some subjective mental impressions which may be traced to the new ovarian function—the sense of completion, and the new relation it establishes with others, and the consciousness that half a lifetime will be under the dominion of a strange periodicity, a mystery to herself. Aside from these there are no newly-developed mental attributes which may be traced to sex. Any thing new in mental vigor which may present itself at this period of life is more clearly explained by the general maturity of mind and body than by the action of a special function, and the state of remote organs.

It has been believed until recently that the removal of the ovaries, by operation or disease, would unsex the woman; that the features would become thin and masculine, the voice harsh, and even a beard develop. This is now known to be a wrong belief. It is true that the removal of these organs has been over-estimated; is it not possible that the commencement of their functional activity has been given undue importance in their reflex effect upon mind and body? This is answered by the fact that so gradual is the growth of mind, and the expanding of the intellectual limits, that the closest observer will not detect the dividing line between childhood and womanhood. Look back, if you will, at the young woman who has grown up under your daily notice, and point out the period of her life—be it one of months or a year—in which sex has become, objectively, a part of brain-fibre. For myself it is impossible to perceive the era of this change, so gradually are the various stages of development merged into each other.

A few words about the function itself concerning which so much is being said. The periodic presence is regarded as an expression of ovarian activity alone. This is in a great measure true; but it is not all the truth. Facts which have been coming to the light in the last few years show that forces not of ovarian origin are engaged in deter-

mining the function and its periodical character. Women from whom both ovaria have been removed have lived on with this function in full force, identical, as to quantity and time, to the function previous to the removal (Peaslee, "Ovarian Tumors," p. 527). Cases have occurred in which the ovaria have never passed out of the rudimentary state, and yet the general character of these women is decidedly feminine, "and never reminds us of viragos" (Klob, "Pathological Anatomy of the Female Pelvic Organs," p. 14). So far as external sexual traits are concerned, such a woman differs in no manner from one who is functionally perfect. The natural inference is, that forces, other than those which spring from the ovaria and their function, are capable of directing development, and that there is a certain amount of sex, that of the general configuration of the body especially, which develops independently of ovarian stimulus.

We may also gain a knowledge, inferentially, of the establishment of ovulation by observing the manner of cessation of this function. Its decline and extinction is a slow and gradual process. This period has a mean duration of nearly three years (Tilt, "Change of Life," p. 65). There are also anatomical changes, which, if taken into account, would greatly extend this time. The gradual decline of the ovarian function is a type of its equally gradual inception. It is a reasonable inference that, whatever takes time in throwing down, also requires time in the building up. So far as the importance of the change of life and the beginning of ovulation are concerned, the latter greatly exceeds the former—I am speaking of the two phenomena as physiological acts—and yet we see the former always attended by anatomical preparation, and by a functional activity so slowly diminished, that even the subject herself is unconscious of the crisis through which she is passing. I have already alluded to the fact that paroxysm, or rapidity in the establishment of a function, is an evidence of disease, and not the healthy way Nature has of doing this work.

In an article of this kind many facts which have a direct bearing upon this question cannot be mentioned in detail. Such a fact is the early vice of a peculiar nature to which very young children become addicted. The impulse to this is generally ascribed to emotions which result from ovarian stimulus; but, on the contrary, the tendency to vice exists long anterior to the development of this function. I can only state the fact that the presence of the passions antedates the appearance of ovulation by months and years; thus, the interest mutually excited in children of opposite sex is not confined to nubile years. In support of this I can appeal to the common experience of adults.

The conclusions at which I arrive are briefly these:

That sex, structurally and functionally, from infancy to puberty, is in a state of slow and progressive evolution.

That the time occupied in the establishment of ovulation is not the true crisis in the development of woman.

That undue value has been given to simple ovarian growth and function as a factor in the development of womanly mental and structural peculiarities.

That in a state of health the inception of the ovarian function is never paroxysmal, or sudden.

That perfect structural development is followed by perfect function, and that the reverse of this is true; and, lastly—

That early diseased ovulation is mainly the result of physical, moral, and hygienic faults of the true crisis of woman—that of formative childhood—rather than of the period of puberty.

With these facts before us, is it not legitimate to assume that the puberic period in woman's life has been over-estimated in its direct influence upon her health at that and subsequent periods? Instead of curtailing her opportunities for work and study, by throwing around her restraints, and, as it were, creating a disability out of a natural function, transfer the attention and anxiety now lavished upon her, to a period when all that makes woman in the best and noblest sense is in a process of elaboration; for it is during this time of rapid structural change that the future good or bad health of the woman is determined. Let healthy ovulation be the natural outcome of a healthy childhood, and the function will obey its law of periodicity year by year, and all this time the young woman is as able to sustain uninterrupted physical and intellectual work as the young man. I do not wish to be understood as saying that at puberty, or at any other period of woman's life, the laws of health may be violated with impunity, but that a law of health is no more binding upon the young woman than upon the young man; that really there is no such thing as one law for women, and another for men. But the law of the woman is not the law of the child. The woman must follow those laws of health which keep her healthy; the child must be trained to obey those which will insure health in the woman. If I am right in tracing ovarian functional derangement mainly to the structural crisis, it is evident that the child must be an object of careful attention. It is not my purpose to mention the causes which will vitiate the development of the child. I desire to direct attention to this period as one full of danger to the future woman. Lest I be accused of ascribing too many of the disasters to which the functional health of women is liable to the period of childhood, I will say that women, and all the functions peculiar to their sex, are liable to the accidents of disease at any time; but, if we accept the evidence of the intelligent people who have the opportunity of observing large numbers of young women in schools and colleges, the early period of sexual function is not so liable to disease as when women are called upon to perform some of the higher duties of their being later in life. Neither is it my object

to prejudice in any way the discussion of the co-education of the sexes. I think society is not prepared to discuss that question now. It is being worked out in the best possible manner, that of actual experiment. But, my aim has been to fix, if possible, the actual value of the puberic age of woman as a crisis, so that there may be no fictitious bar to her progress to either a higher education, or to her training for any of the skilled labors suited to her strength.

## THE HUMMING-BIRDS.

By JAMES H. PARTRIDGE.

THE discovery of America opened up to the civilized world many new objects of interest in the animal, vegetable, and mineral kingdoms. Not the least in interest was the discovery of an extensive group of birds, consisting of several hundred species, whose diminutive size, quickness of motion, boldness of demeanor, elegance of form, and exquisite beauty of plumage, attracted the attention and secured the admiration of every lover of Nature.

The larger portion of these birds live in the West Indies and the tropical regions of America. Some occupy only a small island or district; others, a narrow belt on the side of a mountain: most do not extend their limits beyond a few degrees of latitude, while a few are migratory, and spend the summer in the temperate zone, but return to the tropical regions for the winter. Their food consists of honey and insects; and, consequently, they must live where flowers grow and insects abound. The Indians gave to these interesting little creatures fanciful names that expressed the idea of sunbeams, sun-angels, sun-gems, tresses of the day-star, murmuring-birds, and the like. And naturalists have given to them names equally fanciful, expressing the same or similar ideas, such as brilliant birds, light-bearers, sun-seekers, flower-kissers, honey-suckers, living meteors, and many others of similar meaning. They derive their common name from the buzzing or humming sound which they make with their wings. These vibrate so quickly as to be visible only as a semicircular film on each side of the body. The sound made by different species varies with the velocity of their wings. That made by the vervain humming-bird resembles the sound of a large bee; while that made by the polytmus resembles the sound of a swiftly-revolving wheel.

One of the peculiarities which first strikes a stranger, upon seeing one of these brilliant breathing gems, is the immense power of wing, shown by the quickness of his flight, also by the ease with which he balances himself in the air, whether, foraging unmolested, he is feeding at the flowers, or, attracted by curiosity, he is surveying one's

person. He comes so suddenly as to give no warning to the eye; we hear a buzz, see the bird near us stationary, his form distinct, and when he leaves, so quick and sudden is his flight, that the eye can scarcely trace his pathway. The muscles of his wings are more powerful and active, in proportion to his size, than those of any other bird, and the wings are very long and sharp. For this reason he can easily hover, apparently motionless, for any length of time, before a flower whose honey he wishes to obtain. He thus sips the nectar of one flower after another for hours in succession, without showing any signs of weariness, or disturbing in the least the most delicate blossom.

FIG. 1.

RUBY-THROATED HUMMING-BIRD (*Trochilus colubris*), common in the United States.

If any one wishes to observe these birds and their habits, let him, on a fine, pleasant morning, visit a cluster of gooseberry bushes when in bloom, of whose honey they are exceedingly fond, and he will probably find one or more of them quietly searching the flowers for food. If disturbed, he will frequently rise to a considerable height in an oblique direction, then dart down, almost with the velocity of a bullet, past the place of annoyance, and rise on the opposite side to an equal height; then return by reversing his course, and so repeat these sweeping movements, till he sufficiently expresses his disapprobation, drives away his adversary, or retires in disgust.

If two birds foraging come together, they usually fight; one drives the other away, and then goes on feeding as if nothing had happened. Mr. Gosse says: "If two vervain humming-birds are about the moringa-tree, one will fly off and suspend himself in the air a few yards distant, the other presently shoots off to him; and then, without touching each other, they mount upward with strong, rushing wings, perhaps for 500 feet. They then separate, and each shoots diagonally toward the ground, like a ball from a rifle, and, wheeling round, comes

up to the blossoms again, and sucks, as if it had not moved away at all. The figure of the smaller humming-birds on the wing, their rapidity, their arrowy course, and their whole manner of flight, are entirely those of an insect: and one, who has watched the flight of a large beetle, or bee, will have a very good idea of one of these tropic gems, painted against the sky." Again he says: "I once witnessed a combat between two mango humming-birds, which was prosecuted with much pertinacity, and protracted to an unusual length. They chased each other through the labyrinth of twigs and flowers till, an opportunity occurring, the one would dart with fury upon the other, and then, with a loud rustling of their wings, they would twirl together round and round, until they nearly came to earth. At length an encounter took place pretty close to me, and I perceived that the beak of the one grasped the beak of the other, and, thus fastened, both whirled round and round in their perpendicular descent, till, when very near the ground, they separated; and the one chased the other for about a hundred yards, and then returned in triumph to the tree.

Fig. 2.

Mango Humming-bird (*Lampornis mango*).—1. Male; 2. Female.

Sometimes they would suspend hostilities to suck a few blossoms, but mutual proximity was sure to bring them on again, with the same result. In their tortuous and rapid evolutions, the light from their ruby necks would now and then flash in the sun with gem-like radiance. The war lasted fully an hour, and then I was called away from the post of observation."

When these birds have nests, they defend them with great energy. They will attack and drive away any bird, however large, that disturbs them, or encroaches upon their territories. Wood says: "It has even been seen to attack the royal eagle itself, and to perch itself upon the head of its gigantic enemy, pecking away with hearty goodwill, and scattering the eagle's feathers in a stream, as the affrighted

bird dashed screaming through the air, vainly attempting to rid itself of its puny foe." If a person comes near their nest, they will frequently hover very near, and scrutinize him with great deliberation and coolness. We learn from Humboldt, that, "according to the religious belief of the Mexicans, Torgamiqui, the spouse of the god of war, conducted the souls of those warriors who had died in the defense of the gods into the mansions of the sun, and there transformed them into humming-birds—an idea exquisitely spiritual, but perhaps only to be appreciated by those who have seen these birds gleaming like meteors, or shooting-stars, in their native regions."

All these birds are very small. The vervain humming-bird, of Jamaica, is one of the minutest of those at present known. Its body is less than an inch and a half long; its tail, less than an inch; and its total length less than three inches. Most are a little larger, and have longer tails. The largest bird in the family is the gigantic humming-bird of Chili, well proportioned, and nearly eight inches in length.

More than three hundred different species of humming-birds, or *Trochilidæ*, as the family is called, have been minutely described, and specimens carefully prepared and preserved. Many more species are supposed to exist in Mexico, and in the wilds of Central and South America. The family is divided, by Wood, into twenty-eight genera. While the earlier writers made a less number of divisions, some of the later European naturalists have made a much greater number: in one instance, no less than seventy-six genera and sub-genera. The extent of the family will be apparent when we consider that "the total number of the birds of Europe, of every order or group, amounts to no more than 503 species," while there are probably between 400 and 500 species of humming-birds that are included in this one family.[1]

Their bills are all very slender and sharp. Most of them are long; some are straight; many are curved downward; and a few are curved upward. They all appear to be adapted to the kind of flowers from which the birds obtain their food. Their tongue is a slender sucking-tube, and capable of being thrust out a long distance. It appears as though composed of two minute muscular tubes, lined within by two partial tubes of a substance resembling parchment, laid side by side, and joined together for about half of their length, but separate toward the tip, near which each partial tube becomes less curved, and apparently widened, then tapers to a point, the upper edge being irregularly notched or slit, the barbs pointing backward. The tongue is constantly moistened by a glutinous saliva, by means of which it is

[1] On the upper floor of the old Arsenal, in Central Park, New York City, at Sixty-fourth Street, there is a collection of several hundred prepared specimens of humming-birds, illustrating the great number and variety of species, and the extreme brilliancy and beauty of their plumage. This collection furnishes an opportunity, to any one who has the taste and leisure, to study this minute but interesting portion of natural history.

enabled to seize and hold insects. Says Martin: "It is by a pumping or sucking action, as we have every reason to believe, that nectar or fluids are absorbed by the tubular tongue of these birds. In no other vertebrate animals, as far as we know, is the tongue constructed as a tubular sucking-pump: so far, the humming-birds stand alone; and this circumstance in itself, considering it with reference to organic structure, might be adduced as a reason for regarding these birds as a distinct order."

Mr. Thomas Belt, author of "The Naturalist in Nicaragua," indicates another function performed by the curious cleft tongue of the humming-bird, viz., the capture of insects. As we have seen, this organ is, for one-half its length, made up of a substance like rather stiff parchment, or horn, and split in two. When at rest, the two

FIG. 3.

TONGUE OF HUMMING-BIRD, WITH BLADES A LITTLE OPENED.

halves are laid flat against each other, but they can be separated at the will of the bird, and form a pair of forceps, admirably adapted for picking out minute insects from among the stamens of flowers.

We may admire the elegance of form and the quickness of motion of these birds, but the dazzling splendor of their plumage, resembling that of burnished metal or polished gems, changing with every change of position, has a charm for the dullest observer, and a fascination for the more sensitive. The wonderful change in color that takes place, according to the position of the light, from brilliant green, through the brightest golden tints, to intense velvety-black, or from black to emerald, or ruby, or crimson, or flame-color, reminds one of fairy-land, or the tales of the genii. Where a metallic lustre prevails, the plumage is always composed of feathers so shaped as to appear to have the form of scales. The birds vary in respect to the parts that have these feathers. While most have them on the throat, many have them on the breast and head; others have them also on the back; some have them on the wing-coverts or tail; and a few have them on nearly all parts, except the long wing-feathers, which are generally of a purplish-brown. It may here be asked, What causes the gorgeous metallic lustre of their plumage, and the rich, changing tints of the various colors, representing every hue of the rainbow, purple, amethyst, fiery crimson, brilliant ruby, radiant topaz, emerald green, resplendent blue, and glossy violet, which, in certain lights, often gleam with a refulgence that almost dazzles the eye? They have been attributed to various causes; but it appears to be the condition of the surface of the feathers that produces the iridescence. The surface is striated, or has minute furrows, like the nacre, or mother-of-pearl of the *Haliotis*, and other sea-shells, which decompose the light—absorbing part, and re-

flecting part; and the color of the reflected light depends upon the angle of the incident ray to the surface, and varies as the angle varies. In one direction of the incident ray, the light will be wholly absorbed, and, none being reflected, the surface will appear intensely black. It will readily be perceived that every movement of the bird produces more or less a change of color. Even the heaving of the breast, in breathing, sometimes produces perceptible changes.

The nests of humming-birds are curiously, skillfully, and quickly made. Most of them are formed of the down of the gigantic silk-cotton tree, or other vegetable fibres, worked into a sort of wadding or felt, and covered on the outside with particles of lichen, moss, webs of spiders, etc., the saliva of the bird being used to assist in holding the parts together. They are generally cup-shaped, or conical. Martin says: "In position, these nests are as different as imagination can conceive. Some are attached to the fork of a branch; others are bound to a waving twig enshrouded by foliage; others are pendent, attached to the extremity of the leaves of palms, flags, and other plants, overhanging water; others, again, build on rocks, hanging their nests by filaments to the sides of bold precipices; others hang their nests to the extremity of slender, pendent tendrils. Their eggs are two in number, white, but often, from their transparency, they display the color of the yolk, the shell appearing as if tinged with a blush of orange-red or pink. The eggs are a long oval, measuring, on the average, from three-eighths to one-half of an inch in length." Captain Lyon, writing from Gongo Soco, Brazil, says: "It may interest you to have an account of some young humming-birds, whose hatching and education I studiously attended, as the nest was made in a little orange-bush, by the side of a frequented walk, in my garden. It was composed of the silky down of a plant, and covered with small, flat pieces of yellow lichen. The first egg was laid January 26th, the second on the 28th, and two little creatures, like bees, made their appearance on the morning of February 14th. The old bird sat very close during the continuance of the heavy rain for several days and nights. The young remained blind until February 28th, and flew on the morning of March 7th, without previous practice, as strong and swiftly as the mother, taking their first start from the nest to a tree about twenty yards distant." The intense activity of humming-birds makes it necessary for them to have food containing nitrogen, which they get by feeding on insects. Honey furnishes proper food, or fuel, for the lungs, but it alone cannot form muscle, or give strength. They resemble the swifts in their powers of flight; the woodpeckers, in their means for darting out the tongue; and the sunbirds, in the metallic lustre of their plumage.

The ruby and topaz, or ruby-crested, humming-bird (*Chrysolampis moschitus*, Boié) derives its common name "from the color of its head and throat, the former being of a deep ruby tint, and the latter

of a resplendent topaz." Chrysolampis, or gold-gleaming, is also very expressive of its appearance. On the head of the male bird, the feathers are elongated, and form a short, rounded crest, which can be raised or lowered at pleasure. The crest and upper part of the head appear of the most brilliant ruby-red, of a bright coppery lustre, or of a deep, sombre reddish-brown, according to the direction of the light and the observer. The throat and breast appear of the most brilliant topaz-

Fig. 4.

Nest of Ruby and Topaz Humming-bird.

yellow, of a clear golden-green, or of a sombre greenish-brown, under similar circumstances. Jardine says: "It is impossible to convey by words the idea of these tints; and, having mentioned those substances to which they approach nearest, imagination must be left to conceive the rest." The upper parts of the body are velvety bronze-brown, the tail-coverts having a greenish tinge, and the wings are purple-brown. The broad and expansive tail is of a "rich chestnut-red, tipped with black, and the abdomen is of a dark olive-brown. The female has none of the ruby patches on the head, but retains a little of the topaz on the throat."

This species lives in the West Indies, and in various parts of South America. "It is in great request for the dealers, and thousands are killed annually. No species is so common as this in ornamental cases of humming-birds." Humming-birds are not only used for cabinet-specimens, but for various purposes of embellishment. The feathers are used to make flowers, pictures, and other ornaments. The birds are killed in various ways. Some are shot; but they are frequently so injured by this method as to be of little value. By the use of the *sarbacane*, or shooting-tube, they can be stunned and taken without much injury. They are sometimes caught in nets uninjured; and occasionally they are taken by putting bird-lime, or other glutinous substance, in flowers which they habitually visit.

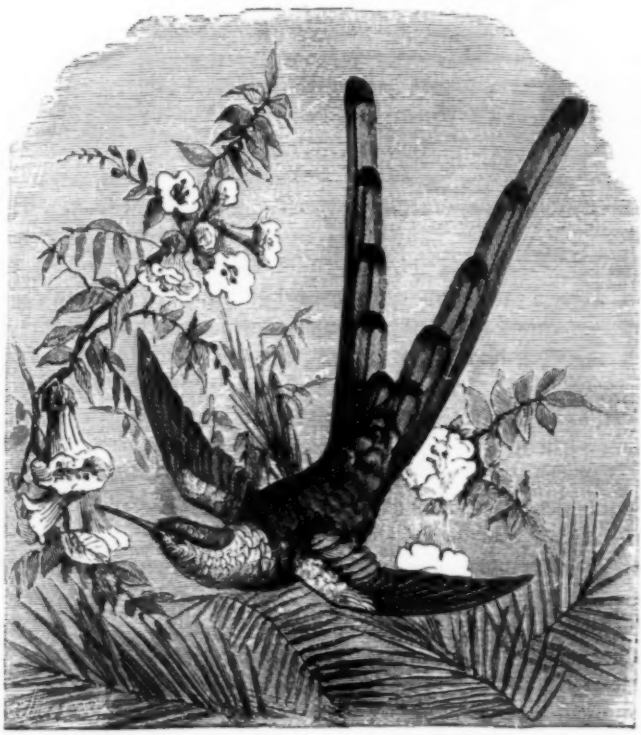
The nest of this species is formed almost entirely of cotton or fine grass, and is thick, compact, and warm, the inside being about an inch in diameter, and the same in depth. It is frequently attached to a leaf, put on the small branches of a rush, or built on the twig of a small bush. Mr. Kirk, residing in the island of Tobago, says: "The ruby-crested humming-birds make their appearance here on the 1st of February. They begin to make their nests about the 10th. I now know (March 1st) of several containing two eggs each; and watched a bird building one yesterday for nearly an hour. Her manner of construction was very ingenious: bringing a pile of small grass or lichen, she commenced upon a small twig about a quarter of an inch in diameter, immediately below a large leaf, which entirely covers and conceals the nest from above, the height from the ground being about three feet. After the nest had received two or three of these grasses, she set herself in the centre, and, putting her long, slender beak over the outer edge, seemed to use it and her throat much in the same way as a mason does his trowel, for the purpose of smoothing, rubbing to and fro, and sweeping quite around. Each visit to the nest seemed to occupy only a couple of seconds, and her absence from it not more than two minutes. A few hours after I saw the nest, which had all the appearance of a finished one."

The sappho comet, or bar-tailed humming-bird (*Cometes sparganurus*, Gould), is remarkable for the development and splendid color of the tail of the male bird. The feathers are broad and truncate, and the outer pair five or six inches long, the others decreasing rapidly toward the inner ones. They are of a brilliant reddish orange, with a metallic lustre of the greatest clearness, assuming a greater tinge of red or yellow, according to the direction of the light. The tail is darker at the base and of a lighter or more fiery red toward the extremity. The tip of each feather has a broad black bar, and when the tail is closed these tips appear as five black bars or bands. The upper parts of the head, neck, and body, are of a golden green; the rump, of a fine madder-red without lustre; the sides of the face and neck are bronzed; wings, purple-brown; the throat and breast are of a bright

emerald-green, with very brilliant metallic lustre; the abdomen, darker green. The female is smaller than the male, and has a shorter tail, and less brilliant color.

This species is a native of Bolivia, but spends the winter in Eastern Peru. It migrates southward to Bolivia in September or October, the spring of their year, raises its young, and, after spending the summer, returns northward with them in March or April, their autumn, to Eastern Peru. It is a remarkably familiar bird, for it not only feeds

Fig. 5.



Sappho Comet.

upon the flowers of the forest-trees, but visits the orchards when in bloom, the cottage shrubbery, the gardens, and the cultivated fields of maize, pulse, and other leguminous plants. It obtains an abundant supply of insect-food from the rich flowers of the cactus family. Mr. Bonelli says: "The difficulty of shooting these birds is inconceivably great, from the extraordinary turns and evolutions they make when on the wing; at one instant darting headlong into a flower; at the next, describing a circle in the air with such rapidity that the eye,

unable to follow the movement, loses sight of it, until it again returns to the flower which at first attracted its attention."

The ruby-throated, or northern, humming-bird (*Trochilus colubris*, Linnæus) is so called, says Wood, "on account of the glowing, metallic feathers that blaze with ruby lustre upon its throat, and gleam in the sunshine like plumes of living fire. The general color of its upper surface and the two central tail-feathers is light, shining green, glazed with gold. The under parts of the body are grayish-white intermingled with green; and the throat is of the most gorgeous ruby carmine" tint, which changes, with the change of light, to a fiery crimson, to a burning orange, or to the deepest velvety black. The wings and eight tail-feathers are purplish-brown. The throat of the female is white.

The ruby-throats arrive in Louisiana and Florida in the first part of March, and, gradually proceeding north as the weather grows warm, arrive in Pennsylvania in the latter part of April, and in New York and Canada in May. They generally build their nests two or three weeks after their arrival. They usually place them a few feet from the ground, on an almost level branch of some tree, as the white-oak or pear tree, and extend the bottom of the nest round the limb so as to inclose it and appear as a mere mossy knot, or natural enlargement. Audubon says: "The nest of this humming-bird is of the most delicate nature, the external parts being formed of a light-gray lichen, found on the branches of trees or on decayed fence-rails, and so neatly arranged round the whole nest, as well as to some distance from the spot where it is attached, as to seem part of the branch or stem itself. These little pieces of lichen are glued together by the saliva of the bird. The next coating consists of cottony substances, and the innermost, of silky fibres, obtained from various plants, all extremely delicate and soft. On this comfortable bed, as if in contradiction to the axiom that the smaller the species the greater the number of eggs, the female lays only two, which are pure white, and almost oval. Ten days are required for their hatching; and the birds raise two broods in a season. In one week the young are ready to fly; but are fed by the parents for nearly another week. They receive their food directly from the bill of their parents, who disgorge it in the manner of canaries and pigeons." They probably join the young of other broods, and migrate without the old ones. They no not receive their full brilliancy till the next spring. When caught in a gauze net they easily die, or simulate death.

The ruby-throat has sometimes been tamed. Mr. Webber, in his "Wild Scenes and Song Birds," says, after several unsuccessful attempts, at last "I succeeded in securing an uninjured captive, which, to my inexpressible delight, proved to be one of the ruby-throated species, the most splendid and diminutive, that comes north of Florida. It immediately suggested itself to me that a mixture of two parts of loaf-sugar, with one of fine honey, in ten of water, would make about

the nearest approach to the nectar of flowers. While my sister ran to prepare it, I gradually opened my hand to look at my prisoner, and saw to my no little amusement as well as suspicion, that it was actually 'playing 'possum'—feigning to be dead, most skillfully. It lay on my open palm motionless for some minutes, during which I watched it in breathless curiosity. I saw it gradually open its bright little eyes to peep whether the way was clear, and then close them slowly as it caught my eye upon it. But when the manufactured nectar came, and a drop was touched upon the point of its bill, it came to life very suddenly, and, in a moment, was on its legs, drinking with eager gusto of the refreshing draught, from a silver teaspoon. When sated it refused to take any more, and sat perched with the coolest self-composure on my finger, and plumed itself quite as artistically as if on its favorite spray. I was enchanted with the bold, innocent confidence with which it turned up its keen black eyes to survey us, as much as to say, 'Well, good folks! who are you?' By the next day it would come from any part of either room, alight upon the side of a white China cup containing the mixture, and drink eagerly, with its long bill thrust into the very base. It would alight on my fingers, and seem to talk with us endearingly in its soft chirps." Mr. Webber afterward succeeded in taming several of the same species. He gave them their liberty occasionally, and they returned regularly. At the time for migration they left for the winter; but, the next spring, they sought their old quarters, and accepted the delicious nectar kindly provided for them, and by degrees brought their mates. "He frequently observed, while watching for their nest, that the ruby-throats, after leaving their station, shot suddenly and perpendicularly in the air until they became invisible. At last, he had the great satisfaction of seeing the female bird fall, like a fiery aërolite from the sky, upon the spot where she had built her nest." From this he inferred that, instinctively for concealment, such was their usual practice.

The ruby-throats generally prefer tubular flowers, such as those of the thorn-apple, trumpet-flower, honeysuckle, etc., though, in case of need, they appear not to reject any one that will furnish them food. But there is nothing that will attract them so effectually, under all circumstances, as a large cluster of gooseberry-bushes in full bloom. And any one having such a cluster, and a little leisure, can at the proper season have the opportunity of observing their beauty and studying their habits. And this is very desirable and satisfactory to an inquisitive mind; for words, engravings, paintings, and even cabinet specimens, fail to give a true and full impression of the vivid and changeful tints, like the flashings of the ruby, the topaz, and the emerald, that proceed from these exquisitely beautiful winged gems.

## THE DEVELOPMENT OF PSYCHOLOGY.

THE progress of Psychology has been determined by agencies which may, with much precision, be discriminated as two sets of conflicting yet coöperating forces—those maintaining equilibrium, and those producing motion. This language would be justly condemned as mechanical if it in any degree presupposed the vulgar notion of force, as acting on visible masses of matter and causing sensible motion. But since vital, mental, and even social phenomena, as well as the oscillations of molecules and the ethereal undulations, are now alike interpreted in terms of mechanism, we may reasonably claim that the phraseology shall receive the greatest latitude of interpretation consistent with the admission of no mechanical assumptions. If, with more propriety, it be censured as scholastic, as raising mere observed uniformities into self-acting entities, it may be replied that the term force is scholastic only when used scholastically, that it has a true and unmistakable meaning as a generalization simply, and that progress of all kinds can be best described in the language of the science which has clothed the laws of the action of force with the greatest possible precision and certainty. Under these reservations, we use no mere metaphor in describing the development of Psychology as due to two sets of forces, which may be styled kinetical and statical respectively, according as their function has been to produce external change or to effect those internal readjustments which previous changes had rendered necessary.

The statical factor in psychological history is Theology. The mother of all the sciences, it gives birth to Psychology first of the sciences of mind; all the great problems, the discussion of which carries the science through its subsequent revolutions, are raised by it; and we may find that its perpetual function, of which it can never be discharged, is to recall attention from temporary physical solutions to the insoluble problems themselves.

The kinetical factor is constituted by the whole series of the physical sciences, though at any particular epoch it takes the character of the dominant science. Each stage in the development of Psychology corresponds to some stage in the evolution of the natural sciences; by each such transition has each psychological development been caused and conditioned; and the progress of Psychology in fundamental truth, and its more complete emancipation from Theology and Metaphysics, are to be measured by the degree in which physical methods, physical conceptions, and even physical metaphors, have been applied to the interpretation of the facts of mind.

The primitive savage, looking out upon the world, finds no God; gazing inward upon himself, perceives no Soul; and thinking of the

origin of things, can conceive no Creation. His gods are parts of the world, not makers of it; such soul as he ascribes to himself is merely his own double, which perishes with him or soon after, or he has several souls; and the earth, as he sees it, was not made but hooked up from the bottom of the original sea.[1] To the undiscriminating mind of the savage the Cosmos is accordingly all but homogeneous, with just the beginnings of "differentiation," and God, Man, and Nature, have yet to acquire an independent existence. There is still, therefore, no room for Psychology.

Plato gets several stages further than this. With him the Cosmos is a divine immortal being or animal, composed of a spherical rotatory body and a rational soul. The gods dwell in the peripheral or celestial regions, and men and the animals inhabit the lower or more central regions. The cranium of man is a little Cosmos, with an immortal rational soul, composed of the same materials as the cosmical soul, and moving with the like rotations. Within the body on which this cranium is placed are two inferior and mortal souls; one, the seat of courage, etc., in the chest; the other, the seat of appetite in the abdomen; both of them being rooted in the spinal marrow, which is continuous with the brain, and is the medium of the unity or communication of the three souls.[2] In this semi-barbaric Cosmology we may note that the gods are still mixed up with the Cosmos, though the beginnings of separation are shown by their lodgment in a specific place; that they still want unity; and that there is yet no conception of nature. But we are here more concerned to observe that though the human soul is never actually separated from the body, i. e., is not yet detached from the Cosmos, and though it has the corporeal properties of extension and motion, body and soul, microcosmical and macrocosmical, are set sharply over against one another, and the first decided step toward their absolute separation is taken.

The metaphysical advance of Aristotle is immense. The three Platonic souls are merged in one, though the remains of the old idea are visible in the different attributes and distinct origin of the Nutritive, the Nutritive-sentient, and the Noëtic principles. But the Nutrient principle is the indispensable basis, without which neither of the others can exist, and the next higher principle, the Sentient, implies and contains the lower. In the investigations of the properties of these we have the beginnings of Psychology. It is not yet indeed an independent science, for the soul is still imperfectly extricated from the Cosmos—the Noëtic principle having its proper abode in the concave of heaven, and being only temporarily localized in the human body. The soul is still, as regards man, mortal, though as regards the Cosmos it is imperishable.[3]

[1] Lubbock, "Origin of Civilization," pp. 245–250.

[2] Grote, "Psychology of Aristotle," in Bain's "Senses and Intellect," pp. 612–614.

[3] Ibid.

Between Aristotle and the thirteenth century the metaphysical evolution was slow, and the stages few and short. The idea of God as an independent existence received its first elaboration in the controversies of the Greek Fathers about the Trinity; was perhaps first sharply discriminated by Anselm; and was raised to the highest pitch of sublimation by the Deistic debates of the seventeenth century, with which the "return of the curve" begins. The idea of Nature, isolated alike from God and Man, emerged from the Italian pantheistic schools of the fifteenth century, to be decisively established with the foundation of Natural Philosophy. The idea of the Soul, with which we are here concerned, was the first of the three elements latent in the primitive homogeneous Cosmos to be completely "differentiated." Whether there was any intrinsic necessity in its earlier evolution; whether it was earlier developed because humanity itself and not merely the metaphysicians contributed to it;[1] or whether it was solely the result of the working of the statical factor in the history of Psychology—the necessities of Theology; its first clear, though not complete, extrication may plausibly be placed as high up as the thirteenth century. As with the other two constitutive ideas, its emergence was the issue of a prolonged debate. No mediæval controversy made more noise while it lasted than the fierce war between the Averroists and the Schoolmen *de unitate intellectus* (concerning the oneness of the intellect). Averroës himself, the Arabian Hobbes, had been dead for half a century, but his doctrines had excited an extraordinary ferment among the younger and more speculative minds, and they reached the climax of their popularity just when the Scholastic Philosophy attained in Thomas Aquinas the culminating point in its history. East and West, Semitism and Aryanism, pantheistic absorption and political individualism, in the guise of Aristotle Arabized and Aristotle Christianized, met in final conflict, and the overthrow was, for the time at least, decisive. The theory of Averroës about the Soul was an imposing and picturesque development of the cosmical Psychology of Aristotle. The Nous of Aristotle was only temporarily localized in the body, and, after the death of the matter which it *informed*, returned to the grand region of Form, the Celestial Body. Averroës first severed the Nous from the Cosmos, unified it in humanity which it actualized, and made it eternal there. But it was only the common possession of the race through all time, and not particular to the individual; there were no souls, but only a single vast Soul, of which each generation was the perishable embodiment, but itself imperishable. Simple-minded, undoubting Thomas, with his eternal "Aristoteles dicit," "Aristoteles respondet," "Aristoteles habet" (Aristotle says, replies, has this), as if the question were to be thus settled, had no difficulty in showing that this was not, what the Averroists felt obliged to maintain, the doctrine of Aristotle.[2] But it was an advance upon that doctrine

[1] *See* Michelet, "Histoire de France," book iv., ch. vi.

[2] "De Unitate Intellectûs," *passim*.

without which Aquinas's own unquestionable advance upon Averroës might never, or not so soon, have been made. While, however, Thomas successfully asserted against the Arabians the individuality of the soul,[1] and against the older Aristotelians its substantial unity,[2] there was still another step to be taken before its independence on all sides could be regarded as established, and the ground cleared for the science of Psychology. That step was taken by Descartes, in whom mankind may be said to have come to a consciousness of itself. His "*Cogito, ergo sum*" (I think; therefore I am), was not logical, but genetic. The force of the *ergo* (therefore), as Ferrier long ago pointed out, lay in the fact that the existence of Descartes as a self-conscious being—*sum* (I am)—was resultant upon the process described by the word *cogito* (I think)—the turning of the light of self-consciousness upon the thinking principle itself. We have but extended Ferrier's interpretation from the development of self-consciousness in the individual to the metaphysical evolution of the *ego* (me) in human history. Not till this had been accomplished, and the Mind made a separate individual existence as against God and Nature, was any independent science of Psychology possible. Observations and reasonings on Man, as on the Deity and the Creation, formed part of the "undifferentiated" mass of speculation on things in general called Cosmology or Theology, and latterly, in a mutilated condition, Metaphysics. Any mediæval cyclopædia will furnish illustrations.

Thomas Aquinas, a faithful representative of the frightened orthodoxy of the Middle Ages, unsuspectingly follows the course of Creation, well known to have happened as laid down in the Book of Genesis. After forty-four *Quæstiones* (Questions) on God (under whom he discusses the nature of ideas and the metaphysics of truth) and the Trinity, and thirty on the Angels, the Devils (here arises, naturally, a discussion on the nature of evil), and the seven days of creation and rest, Thomas arrives, by an obvious logical sequence, at the psychology of man. One *quæstio* (question) settles the essence of the soul, another the union of soul and body; three exhaust the powers of mind in general and special, and the intellectual powers; four expound appetite, sensuality, the will, and free-will; and, having in seven more disposed of the remaining faculties of the soul, including such small subjects as "the mode and order of intellection," Thomas is prepared to deal with the production of man's body, and then evidently with the production of woman's body.[3] A witty journalist is reported to have said of an eminent living thinker, "God made the world in six days, and So-and-so wrote it down on the seventh;" but the entire Synthetic Philosophy might fall out of a corner of the

[1] "Quæstiones Disputatæ." De Spiritualibus Creaturis, artt. ix.–x., and De Anima, artt. ii., iii., v.

[2] Bain, "Mind and Body," p. 181.

[3] "Summa Theologiæ," prima pars, qu. ii.–xcii.

"*Summa Theologiæ*" (Sum of Theology) and hardly be missed. Yet, arrogant as this encyclopedic comprehensiveness now seems, there was really nothing else to be done. Mathematics was the only one of the natural sciences which had succeeded in disengaging itself from theology; there was no social science, no independent science even of politics; there was no history other than ecclesiastical; and (what concerns us here) there was no science of man. Man was not yet a unit in the creation, and inquiries concerning him were properly included in Cosmology, which is pagan for Theology. "*Naturam autem*," says Thomas, "*hominis considerare pertinet* ad Theologum *ex parte animæ*"[1] (It is the theologian's province to consider man's nature on the soul's side). The *theologus* kept hold of the nature of man till Descartes had emancipated him from his serfdom; but to him and his theological science—our statical factor—we may justly ascribe that first successful raising of the problem of human individuality which made possible, as we shall see, its establishment and utilization under the influence of the dynamical factor—physical science.

The fostering aid of Theology to Psychology does not, however, end when the latter is able to walk alone. All great questions subsequently raised, the settlement of which by physical methods marks each fresh stage, issue from the theological *incunabula* (cradle) where the science was reared. A history of the embryogeny of ideas would demonstrate that ideas which were afterward properly philosophical were at first purely theological. The idea of the infinite, at first negative, was made positive, through being made theological, by the Greek Fathers. Prof. Jevons believes that his "Law of Simplicity," though almost unnoticed in modern times, was known to Boëthius, and he adds:

> "Ancient discussions concerning the doctrine of the Trinity drew more attention to subtle questions concerning the nature of unity and plurality than has ever since been given to them."[2]

With greater emphasis, which, however, only exaggerates an important truth, it has been said that the doctrine of the Trinity is the "foundation of all the metaphysical thought and speculation of the ages after Gregory the Great."[3] This will be sufficiently near the mark if the honor is shared with the dogma of Transubstantiation after, say, the "captivity" at Avignon. In more recent times, especially in Germany in the first half of the present century, the doctrine of the Incarnation has been the "motive" of various metaphysical developments.

In Psychology the final cause of Locke was theological; for the rise of an *a priori* philosophy in Herbert of Cherbury was theological, and it was to overthrow apriorism that Locke undertook his examina-

[1] "Summa Theologiæ," prima pars, qu. lxxv. [2] "The Principles of Science," i., 40.
[3] Quoted in Mullinger, "History of Cambridge University," p. 55.

tion of the "original, certainty, and extent of human knowledge." Berkeley avowed that his motive, in investigating the nature of perception, was to provide a bulwark against the atheists. Hume is essentially theological, and in his "Inquiry concerning the Human Understanding," a section on Miracles stands side by side with one on the Idea of Necessary Connection. Reid wrote his "Essays on the Powers of the Human Mind" to refute Hume, and became, with this theological motive, the founder of Scotch psychology. Kant undertook his "Criticism of Pure Reason," and thus established *a priori* psychology, to show against Hume that the ideas of God, freedom, and immortality, could not be disproved by mere empirical reasoning. And the impulse which Hamilton, through Mansel, communicated to Psychology, by the new face he gave to the old problem of the Infinite, was a theological movement in its origin.

Under whatever name we give to it, under whatever form it may hereafter assume, Theology, the science of causes, essences, and origins, will play, as it has hitherto played, an important part in the development of the mental sciences, and especially of Psychology. When physical science is driving its ploughshare into untrodden regions till now only gazed down upon by the metaphysician in his balloon; when the speed of thought itself is measured; when the most complex effort of quantitative reasoning is proved to be fundamentally indentical with the simplest perception of relation; when the nature of intelligence is tracked upward in graduated sequence from the Radiata and Articulata to Newton and Shakespeare; and when the physical sides of all but the most subtle mental phenomena are being identified; the temptation is great to suppose that we are nearing the goal—that as so many laws of mind have been explained by physical laws, and so many facts interpreted in physical terms, the time is at hand, or at least will come, when the nature of causation, and of the substance of mind, and of the relation of phenomena to their source, and of that inscrutable source itself, will yield their secrets to the analysis of the inquirer armed with the weapons of physical science. Whatever power stands in the old place of Theology, which is dead—whether Metaphysics, if that be not dead also, or some "Unknowable" section of our compendiums of first principles—will show all such Comtist dreams to be vain, by eternally asking the unanswerable questions which it has been asking since the beginning of speculation. And each old question newly asked after each fresh advance of physical science tends to restore the equilibrium deranged by the operation of that dynamical factor, the history of the effects of which we will now briefly sketch.

The application of physical methods to the phenomena of mind we believe to have originated in the fact that, outside the territory which (as we saw by the quotation from St. Thomas) was sacred to

the *theologus*, there was a sort of no-Man's land, which profane persons might enter into and possess. For Aquinas goes on: "Non autem ex parte corporis, nisi secundum habitudinem quam habet corpus ad animam."[1] That is to say, while the *anima intellectiva* (intellective soul), which issues directly from the hand of God, is the exclusive province of the theologian, the *anima sensitiva* (sensitive soul), which is propagated in a physical manner,[2] the passions, and the appetites, may be left to the uncowled cultivator of science as not requiring the help of divine inspiration. It was at any rate in this field that the foundations of inductive psychology were laid, and it was to the explanation of the simpler phenomena of sensibility that physical conceptions were first applied. The two greatest thinkers of the seventeenth century were almost simultaneously on the ground.

Descartes is not now remembered by his "Treatise on the Passions" (which was published within a year of Hobbes's work on "Human Nature"), and we only note it here as an early example of experimentalism in Psychology. We are more concerned to observe that his vindication of the immateriality of the thinking principle, and his clear perception of the unity of the mental aggregate, were almost contemporaneous with the "new geometry." We are not, indeed, solicitous with regard to Descartes to justify our thesis—that each advance in Psychology has been caused and conditioned by a corresponding and previous advance in physical science; for the enunciation of the Cartesian principle was less a fact in Psychology than the accomplishment of a stadium in the metaphysical evolution, which made Psychology possible. But, perhaps, it may not seem fanciful to mention that Cavalieri, "the generally reputed father of the new geometry," published in 1635 his Method of Indivisibles (which had been largely anticipated by Kepler), or to connect his leading principle—that a solid is generated out of an infinite number of surfaces placed one above another as their indivisible elements—with the effort to unite into a single substance, itself localized, the endless multiplicity of the mental manifestations. It is, at least, clear, that the application of physics to mind will follow the development of physics; and as physics has not yet advanced beyond the geometrical stage, as the period immediately preceding "Descartes's Meditations" was the epoch of a great geometrical advance, as we now know that in virtue of the *consensus* (mutual agreement) which governs all social phenomena, all the conceptions of any age are moulded in the same matrix, it seems not wholly imaginary to adduce the psychology of Descartes, who was himself an eminent geometer, as in some degree the result of the dominance of the earliest developed of the sciences.

Emerging from this doubtful region, we pass on to the *terra firma* (firm ground) of demonstrable fact. Hobbes was rather older than Descartes, but he had the advantage of delaying at least the publica-

[1] "Sum. Theol.," pt. i., qu. lxxv. [2] Ibid., qu. cxviii., art. i.

tion of his speculations until another great scientific advance had been accomplished. We cannot state his antecedents better than in his own words:

"The beginning of astronomy, except observations, I think, is not to be derived from farther time than from Nicolaus Copernicus, who, in the age next preceding the present, revived the opinion of Pythagoras, Aristarchus, and Philolaus. After him, the doctrine of the motion of the earth being now received, and a difficult question thereupon arising concerning the descent of heavy bodies, Galileus in our time, striving with that difficulty, was the first that opened to us the gate of natural philosophy universal, which is the knowledge of the nature of *motion*. So that neither can the age of natural philosophy be reckoned higher than to him. Lastly, the science of *man's body*, the most profitable part of natural science, was first discovered with admirable sagacity by our countryman, Dr. Harvey, principal physician to King James and King Charles, in his books of the 'Motion of the Blood' and of the 'Generation of Living Creatures;' who is the only man I know that, conquering envy, hath established a new doctrine in his lifetime. Before these, there was nothing certain in natural philosophy, but every man's experiments to himself, and the natural histories, if they may be called certain, that are no certainer than civil histories. But since these, astronomy and natural philosophy have, for so little time, been extraordinarily advanced by Joannes Keplerus, Petrus Gassendus, and Marinus Mersennus; and the science of human bodies in special by the wit and industry of physicians, the only true natural philosophers, especially of our most learned men of the College of Physicians in London. Natural Philosophy is therefore but young; but Civil Philosophy yet much younger, as being no older (I say it provoked, and that my detractors may know how little they have wrought upon me) than my own book, '*De Cive*' (the Citizen.)"[1]

The application of all this to the psychological philosophy of Hobbes is so patent as hardly to need elucidation in detail. Like his contemporary Descartes, Hobbes was extremely jealous of his independence, and, what was of less consequence, his originality; and one may even now hear, not without surprise and otherwise, the unlucky epigram which makes him say that, if he had read as many books as other people, he would have been as ignorant as they. Hobbes had read a great deal more than he deemed it prudent to admit, and if he had read more still the good effect of it would not have been doubtful. But, like the Greeks in the time of Sophocles, he had an advantage which would have made up for any deficiency of literary acquisition. He lived in an atmosphere heavy with ideas, and at a time when epistolary communication performed the functions very much which scientific journals now fulfill. Hobbes does not appear to have corresponded with Descartes, but he was in constant intercourse, by letter, with Mersenne, who acted as the intermediary between the two philosophers. And, as philosophers then concerned themselves with the whole range of the sciences, there was hardly a speculation stirring the European mind that need have escaped the notice of even a think-

[1] "Elements of Philosophy," Epistle Dedicatory, pp. 8, 9.

er somewhat out of the main lines of communication. Hobbes was, moreover, a traveller, had lived much on the Continent, and had possibly met Galileo at Pisa. It was under the influence of these two men, or rather of the methods they represented—Descartes and mathematics, Galileo and the laws of motion—that Hobbes proceeded to work out his philosophy. In the language of a distinguished professor, to whom we look for an exhaustive account of Hobbes's relations to the science of his time, "he set about reducing all his thoughts into the unity of a system, whose central idea was this of motion, and whose guiding principles were those of mathematical deduction."[1] "His great postulate," says the same writer, "is motion or mutation,"[2] and he makes copious use of it within the sphere to which Aquinas banished the experimental psychologist, and a little beyond. His explanation of sensation is wholly mechanical. The crass materialism with which he set out may have had something to do with his trenchant rejection of the audible, visible, and intelligible species of the Schoolmen, but the hypothesis which replaced them betrays its own origin. "The apparition of light," he says, "is really nothing but motion within."[3] This thesis is more elaborately developed in a passage which we quote at length, as it appears to contain an anticipation of the undulatory theory of light and heat:

"From all lucid, shining, and illuminate bodies, there is a motion produced to the eye, and, through the eye, to the optic nerve, and so into the brain, by which that apparition of light and color is effected. . . . First, it is evident that the fire . . . worketh by motion equally every way. . . . And further, that that motion, whereby the fire worketh, is dilation, and contraction of itself alternately . . . is manifest also by experience. From such motion in the fire must needs arise a rejection or casting from itself of that part of the medium which is contiguous to it, whereby that part also rejecteth the next, and so successively one part beateth back another to the very eye," and so from the eye to the optic nerve, and from that to the brain.[4]

This postulate of motion, applied in this thorough-going manner, led Hobbes to a great discovery in the psychology of sensation. He clearly demonstrated that the secondary qualities of body are purely subjective, and his language is almost strong enough to lead us to believe that he would have gone a long way with Berkeley. For he claims to have proved that "as in vision, so also in *conceptions* that arise from the other senses, the subject of their inherence is not the object but the sentient." If the word "conceptions" be interpreted according to a definition previously laid down in the same treatise, in which the "images produced by things" are described as conceptions, imaginations, ideas, knowledge, it should seem that he might have applied the analysis to the primary qualities as well, had the two sets of properties been as sharply contrasted as now, instead of being first dis-

[1] *Westminster Review*, April, 1867. [2] Ibid. [3] "Human Nature," p. 6
[4] Ibid., pp. 6, 7.

criminated by Descartes and Hobbes. The same conception (motion) is used to explain the feelings, which, when pleasurable, are the result of the vital motion being "helped" by the motions which, having produced conceptions in the head, afterward proceed to the heart.[1] But external objects not only "cause conceptions, and conceptions appetite, and fear;" as the latter are "the first unperceived beginnings of our actions," and as in a state of doubt, appetite and fear rapidly succeed one another, "this alternate succession of appetite and fear . . . . is that we call deliberation."[2] As all Hobbes's successors of the same school have followed him in thus ignoring the *ego*, it may be inferred that every system of experimental psychology is self-condemned to incompleteness, and that no system can cover the whole of the ground which does not make what can only be called metaphysical assumptions.

The psychological advances made by Hobbes were then—that he helped to banish the imaginary entities of the Schoolmen, and substituted for them hypotheses that implied at least *veræ causæ* (true causes); that he replaced the method of deduction from assumed principles by that of observation (which was not yet, however, that of introspection), and thus founded the inductive philosophy of the mind; and that by his summary rejection of the common metaphysical assumptions, and his patient building up on an independent foundation, he decisively separated psychology from the metaphysics in which it was enmeshed.

If the psychology of Hobbes bears evident marks of the daring, speculative character of contemporary physical science, that of Locke witnesses to the change in the tone and spirit of inquiry. If the keyword to Hobbes is Galileo, that to Locke is Sydenham. Locke and Sydenham were both surgeons, were friends, and were of kindred cautious temperament; and the pacific revolution which Sydenham wrought in medicine has been described in language that, with the necessary change of terms, might word for word be applied to the great psychological advance initiated by Locke. A competent writer describes Sydenham as being—

"most careful to exclude the prevailing theories from affecting his study of the facts of disease: he followed the inductive method which his countryman, Bacon, had just completed, and under the guidance of his friend John Locke, himself a surgeon, he applied it to the investigation of disease with splendid success. The laws ruling the prevalence of epidemics were elucidated, and new and old diseases described with an accuracy and graphic coloring which have ever since remained unrivaled. The treatment of disease Sydenham found lamentably uncertain from want of any fixed principle, and from the countless remedies prescribed mainly in accordance with a capricious fashion. In place of this, he left therapeutics an art ordered by the principle of aiding Nature, and observing the indications afforded by morbid processes themselves. . . .

[1] "Human Nature," p. 31.

[2] Ibid., pp. 67, 68.

Bacon had justly reproached the physicians of his time for their neglect to make records of the cases of their patients. . . . Sydenham. . . . by his bedside study again brought it into favor." And finally, "he found English medicine reduced to the lowest state of empiricism—he raised it once more to the dignity of a science of observation."[1]

The disposition in which Locke entered on his inquiry was certainly "to exclude prevailing theories," for he has himself recorded that his Essay originated in a conviction that, before advancing to abstruse problems, "it was necessary to examine our own abilities, and see what objects our understandings were or were not fitted to deal with." His method of induction was truly Baconian: he approached the subject without any clear design, proceeded without a plan, and attained such results as can be so reached. But the "laws ruling the" formation of ideas were elucidated, and mixed and simple modes "described with an accuracy" and in one or two cases with "a graphic coloring" which have not been greatly surpassed. The philosophy of the mind he found an untrodden jungle, with a few bridle-paths in the directions marked "Sense," "Appetite," etc.; he cut a highway through the part where the bush was thickest—the region of ideas. The *a priori* method was in favor, and "bedside study" of the human patient out of fashion; the *a priori* method he did not indeed kill, but he left it to die a lingering death; and though to Hobbes belongs the honor of introducing the experimental method into Psychology, it may be truly said of Locke that he "raised it to the dignity of a science of observation." And just as Sydenham, follower of Hippocrates as he was, attributed a number of diseases to morbid fermentation in the humors, so Locke, in spite of his antischolasticism, could still assign the motion of the "animal spirits" as a "natural cause" of certain ideas.[2] The defects and the merits, in truth, of Locke's procedure were equally those of the physical science of the age. The patient observation of which Sydenham set the example gave rise to the first discriminative account—we can hardly call it analysis—of the proximate origin and more obvious constituents of our ideas. To the same causes and doubtless also to the impulse of conquest in unexplored regions which the post-mediæval world owed to Bacon, we may ascribe it that Locke's "Essay," as he named it, "inquiry," as he described it, was the first comprehensive survey of mental phenomena; while the small part which hypothesis and theory play in his investigation, his incomplete statement of mental causation of all kinds, his bare discovery of association as producing a few obvious compounds, were clearly due to the unspeculative character of the contemporary science to the influence of which he was most exposed.

Berkeley's most notable contribution to philosophy belongs rather to the metaphysics, than to the psychology, of sensation; and his less

[1] Mr. Balthazar W. Foster, in "Essays of Birmingham Speculative Club," pp. 277, 278.

[2] "Essay," book ii., ch. xxxiii.

disputed discovery of the acquired nature of our perceptions of distance we may pass over with the remark that, if the genesis of it could be traced, it would probably be found to have derived its impulse from that "century of inventions" which witnessed Snell's discovery of the law of refraction in 1624, Newton's discoveries in the composition of light in 1674, Huyghens's proof of the polarization of light about 1692, and the explanation of the structure of the eye by Petit in 1700. The conjunction will seem more than a coincidence if it is added that Berkeley's "Theory of Vision," which appeared in 1709, was preceded by Newton's "Optics," in 1705.

The next great advance of Psychology combined, in principle, the advances made by both Hobbes and Locke. As Hobbes had incorporated the conceptions of physical science, and Locke had adopted its methods, we find Hartley professing to follow the "method of analysis and synthesis recommended and followed by Sir Isaac Newton,"[1] and appropriating from the "Principia" the hypothesis of vibrations by which he explained sensation:

"My chief design in the following chapter is, briefly, to explain, establish, and apply the doctrines of *vibrations* and association. The first of these doctrines is taken from the hints concerning the performance of sensation and motion, which Sir Isaac Newton has given at the end of his 'Principia,' and in the *questions* annexed to his 'Optics;' the last from what Mr. Locke and other ingenious persons since his time have delivered concerning the influence of *association* over our opinions and affections, and its use in explaining those things in an accurate and precise way, which are commonly referred to the power of habit and custom, in a general and indeterminate one. . . . One may expect that *vibrations* should infer *associations* as their effect, and association point to vibrations as its cause."[2]

It may seem somewhat bold in Hartley, whose name has almost passed into a by-word as that of an hypothesis-maker, to shelter himself under the ægis of Newton, who declarad—"hypotheses non fingo." But, as is observed by Prof. Stanley Jevons, "the greater part of the 'Principia' is purely hypothetical, endless varieties of causes and laws being imagined which have no counterpart in Nature."[3] Psychology had reached in Hartley's time, as Natural Philosophy in Newton's time, the stage when the mere generalization of observed uniformities is no longer sufficient to cope with the accumulated multitude of ascertained facts, and when some comprehensive hypothesis is required which shall connect the empirical generalizations of one science with the ultimate laws of Nature and the principles of all the sciences. Newton's force of gravity and Hartley's theory of vibrations were such hypotheses. But, besides the intrinsic difference between them residing in the fact that the one could be proved, and the other, at best, only made probable, there was the further contrariety, which explains their very different success, that the Newtonian conception

[1] "Observations," ch. i. [2] "Ibid.," ch. i. [3] "Principles of Science," ii., 228.

was the complement of a slow development. The first natural philosophers, down even to Kepler and Galileo, had contented themselves with studying *effects*, e. g., the orbits described by the heavenly bodies, and the period of their revolutions. But, with the decay of the scholastic metaphysics, which was also physics, a new idea began to stir the minds of men—that of force. It is said to have been conceived by Nicolas of Cusa;[1] it found tortuous expression in Descartes's Vortices;[2] and, specialized as governing gravitation, it was perhaps first dimly seen by Gilbert little less than a century before Newton, was asserted by Kepler nine years later (1609), and in 1674 was stated by Hooke with remarkable clearness and accuracy—all before Newton had thrown out any hint of his sublime discovery.[3] Hartley's hypothesis, on the other hand, was a chance shot, a private guess, and was no matured result of previous theorizing. It accordingly passed into the limbo to which Nature consigns her mistakes; but the gain to Psychology was, though not equally great, of fundamentally the same kind as the gain to Natural Philosophy from the establishment of the law of gravitation. The idea of force subsumed that of law, the conception of causation superseded those of sequence and conjunction; and the basis for an explanation of the phenomena of mind was for the first time sought outside the limits of these phenomena. Hartley was unsuccessful, but the mere attempt has been as a light on high to guide the uncertain steps of later inquirers, and has at last led to the physical syntheses of our own day.

Even a false, or at least a partially true, theory has the advantage of making possible a reasoned arrangement of the facts, as well as the acquisition of more. To Hartley this hypothesis of vibrations gave strength of wing to sweep the entire field of Psychology, and we accordingly find that his was the first systematic effort to explain the phenomena of mind by the law of association.[4]

A very great advance in Psychology was made by James Mill, and it was initiated by Chemistry. During the first ten years of the nineteenth century Chemistry was revolutionized. In 1800 Nicholson and Carlisle decomposed water by means of the Voltaic pile, and enabled Davy in 1806 to make the generalizations which founded electrochemistry. The decomposition of potassa, soda, and other bodies of the same kind, soon followed. Beginning with hydrochloric acid in 1809, the discovery of the various hydracids was made. And in 1803–'04 a great synthetic addition was made to the analytic gains; Dalton's law of chemical combination was established.[5] The influence of these brilliant discoveries upon the thought of the age was not

[1] Morin, in Migne's "Encyclopédie," *Théologie Scholastique*, s. v.

[2] Hallam, "Literature of Europe," iii. (edition 1872), p. 415.

[3] Grant, "History of Physical Astronomy," pp. 16, 17, 29.

[4] Bain, "Mental and Moral Science," p. 633.

[5] Whewell. "History of the Inductive Sciences," iii., pp. 157–159, 141, 142, 145.

doubtful. The literature of the day was drenched with metaphors taken from the dominant science. Fashion, after a long interval, once more patronized Nature, and the "bottle-and-squirt mania" spread. Experimentalism in Psychology was still under a cloud, from the discredit which had attached to the premature theorizing of Hartley. But in the early part of the century, Dr. Thomas Brown had gained a hearing, under cover of the respectable orthodoxy of the Scotch universities, for speculations thickly sown with revolutionary germs. One of his pupils was James Mill, and in 1829 that resolute and thorough-going, if narrow and aggressive, thinker published the treatise which marked the turn of the tide. Deriving his inspiration from the neglected work of Hartley, gathering up the hints freely scattered in Brown's lectures, and imbued with the spirit of the prevailing chemistry, he set about constructing a new science of mind, of which the physics should not be obsolete, and which should push the analysis of the accepted metaphysical mysteries to the farthest possible limit. He obeyed the double analytic and synthetic movement in contemporary chemical investigation. As specimens of his analytical advance, we may point to his further resolution of the apparently simple ideas of hardness and extension, which had been begun by Hartley and continued by Darwin.[1] But, as better illustrating the dynamical influence of physical science, we prefer to lay emphasis on what may, as it appears to us, be justly styled his synthetical contribution to Psychology. This was his conception, applied to the whole range of mental phenomena, of the chemical nature of association. Quite to realize the new shape which the welding mental power took in his hands, we must glance back at its history. It is comparatively young. Hobbes knew nothing of it: his "synthesis," by which things are "constructed or generated," is purely geometrical,[2] and with him association is mere sequence.[3] Locke's advance on this is clear, though inconsiderable: he speaks of the "tying together of ideas," and describes certain ideas as appearing in "gangs, always inseparable,"[4] but he regards "mixed modes" as made by men voluntarily with a view to communication.[5] Hartley, according to Mr. J. S. Mill, had reached the stage we have above stated as only attained by James Mill:

> "It was reserved for Hartley to show that mental phenomena, joined together by association, may form a still more intimate, and as it were chemical union; . . . the compound having all the appearance of a phenomenon *sui generis*, as simple and elementary as the ingredients, and with properties different from any of them."[6]

This is far too strongly stated. That the union of the associated mental elements as conceived by Hartley was more intimate than their mode of conjunction as conceived by Locke, or their rigidity of sequence

[1] "Analysis," i., 92.
[2] "Elements of Philosophy," i., pp. 312, 313.
[3] "Human Nature," ch. iv.
[4] "Essay," book ii., ch. xxxiii.
[5] "Ibid., ch. xxii.
[6] "Dissertations," iii., 108.

as imagined by Hobbes, is unquestionable; but how Mr. Mill could describe that union as chemical, and as analogous to the compound formed like water, by hydrogen and oxygen, is inexplicable if it be remembered that the composition of water was not discovered by Cavendish till 1784—thirty-five years after the appearance of the "Observations"—and that Chemistry only passed from the metaphysical to the positive stage with the deposition of phlogiston by Priestley and Lavoisier in the last quarter of the century. The following quotations from Hartley himself will confirm this *a priori* argument by showing the real nature of association as figured by him:

"Upon the whole, it may appear to the Reader, that the simple Ideas of Sensation must run into Clusters and Combinations, by Association; and that each of these will, at last, coalesce into one Complex Idea, by the Approach and Commixture of the several compounding Parts."[1]

No chemist would describe chemical union as "coalescence," or speak of the new substance produced by the operation of affinity as made up of "clusters and combinations" by the "approach and commixture" of parts. As appears still more clearly when Hartley proceeds to explain and illustrate this "coalescence," he had in his mind, as the physical type of his conception, no more "intimate union" than that combination of different kinds of matter called *solution:*[2]

"If the Number of simple Ideas which compose the complex one be very great, it may happen that the complex Idea shall not appear to bear any relation to these its compounding Parts, nor to the external Senses upon which the original Sensations, which gave Birth to the compounding Ideas, were impressed. The Reason of this is, that each single Idea is overpowered by the Sum of all the rest, as soon as they are all intimately united together. Thus, in very compound Medicines, the several Tastes and Flavors of the separate Ingredients are lost and overpowered by the complex one of the whole Mass: so that this has a Taste and Flavor of its own, which appears to be simple and original, and like that of a natural Body."[3]

We should be disposed to describe Hartley's view of mental composition as bearing a similar relation to James Mill's synthesis as Newton's composition of light to Goethe's theory of colors—as implying some species of union closer than the mechanical and less binding than the chemical. Thomas Brown clearly stated the law, as chemically conceived, in one of his introductory lectures. In mere statement James Mill's exposition is no advance upon Brown's, but the law took enormous extensions in his hands, and was applied to the senses, the feelings, memory, classification, language, ratiocination, the will, belief, etc. Something has been added to his synthesis, and a little has been taken from it, but he appears to have made as much as could be made out of the bare laws of association, unextended to the rest of

[1] "Observations," p. 74. [2] Youmans, "New Chemistry," p. 55.
[3] "Observations," p. 75.

the animal kingdom, and confined to the existing generation. His conception of the indissolubleness of certain associations, in particular, preluded the elucidation of their organic character as resulting from the intercourse of the mind with its environment.— *Westminster Review.*

## THE FIELD TELEGRAPH.

By A. HILLIARD ATTERIDGE.

IN the year 1802, when Napoleon was first consul, there arrived in Paris two artisans of Poitiers. One of these men, Jean Alexandre, had invented a rudimentary form of the electric telegraph, and, with his friend Beauvais, he had left the little country town full of high hopes to submit his discovery to the great soldier who was then guiding the destinies of France. He requested a personal interview with the first consul, refusing to communicate his secret to any one else. He was referred to the astronomer Delambre, whom he succeeded in convincing of the value of his invention; still, however, declining to reveal the way in which the electric signals were transmitted, unless to Napoleon himself. But the latter refused to grant the required interview, saying he had no time to trouble himself with such matters; and Alexandre and Beauvais went back to Poitiers in bitter disappointment.[1] Had Napoleon listened to the proposals of Alexandre, the course of history might have been changed; for, had he been able to secure the exclusive possession of the electric telegraph, it is easy to imagine the effect it would have had upon his campaigns, and how difficult it would have been for even the allied armies of all Europe to contend against a great commander, who, by some secret means unknown to them, could obtain accurate and instantaneous information from every point of the theatre of war, and flash his orders to *corps-d'armée* divided from him and each other by miles of country, while his opponents had only to trust to horses and couriers to carry their orders and dispatches.

A very little study of the wars of the French Revolution, in comparison with those of our own time, will be sufficient to show what an advantage the telegraph is to the modern commander. A striking instance of the extreme difficulty of combining the operations of separate corps or armies in the same theatre of war, without the aid of the telegraph, is afforded by the history of the campaign of 1796, in Germany, when Moreau and Jourdan were "acting in concert" against the Austrians. The Archduke Charles left a weak retarding force in front of Moreau, while he directed all his available strength against Jourdan; and the former general was actually advancing in triumph

[1] Villefranche, "La Télégraphie Française, Étude Historique."

through Southern Germany, under the full conviction that his colleague had obtained a like success to the northward, while the latter had actually been defeated at Amberg, Wurtzburg, and Aschaffenburg, and driven back upon the Rhine, and Moreau only heard of his disaster in time to save his army from destruction by a hurried retreat through the defiles of the Black Forest. As a contrast to this, let us take the campaign of 1866, when the two Prussian armies advanced from separate bases into Bohemia, laying down the lines of the field telegraph as they moved forward, which, being connected by the permanent telegraphic system of Saxony, kept each army in constant communication with the other, and thus enabled them to combine their operations, and at length to unite with decisive effect on the battle-field of Sadowa.

It is just twenty years since, for the first time, the electric telegraph was used in the field, and to the British army belongs the honor of having led the way in its adoption. The trenches and batteries before Sevastopol were traversed and connected by lines of telegraph, and the French soon followed our example and constructed a similar system in their own lines; while later on a cable laid across the Black Sea put the armies in the field in direct communication with Paris and London.

Since that time a regular telegraph corps has been organized in every European army. And the field telegraph was used by the French in Italy in 1859, and in their campaigns against the Kabyles in Algeria; and, in America, both the Federals and Confederates made free use of permanent and temporary lines during the war of secession, the Southern cavalry in particular displaying great daring and enterprise in riding round the flanks of the Federal armies, seizing their telegraph-lines, sending false messages to the Northern generals, and then cutting the line and retiring as rapidly and secretly as they came. It was, however, in the Prussian army, and in the great campaigns of 1864, 1866, and 1870–'71, that military telegraphy attained its greatest development; and, after the experience of these three wars, the Prussian telegraph corps is probably the most efficient in Europe. We have already seen how well it did its work in the campaign of 1866,[1] and in 1870 it established the net-work of wires over the northeast of France, that enabled Moltke, sitting in his bureau at Versailles, to move his armies as accurately and certainly as pieces on a chessboard; while round Paris itself a circle of telegraph-wires—that in a moment flashed information of a sortie, and orders for a reënforcement of the threatened point, to every part of the long line of sixty miles, on which the besiegers lay—contributed almost as much toward the

[1] During the armistice which preceded the Treaty of Prague in 1866, the Prussians displayed great carelessness about their telegraphic communications, and the troops often tore down a line to light their fires with the telegraph-poles, and tie up their horses with the wire.—(*See* STOFFEL, "*Rapports Militaires.*")

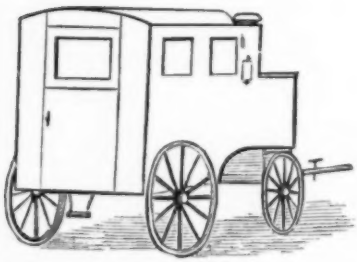
reduction of the vast fortress as the circle of steel and iron, of batteries, earthworks, and redoubts, which, without the connecting link of the telegraph-wire, could not have been maintained for a single month. On their side the French displayed no less energy. The regular telegraph corps was shut up in Metz or lost at Sedan; but a fresh corps was organized for the armies of the republic, and at Paris the telegraph-lines linked together the *enceinte*, the forts and outworks, and the headquarters of General Trochu. But it was in the second siege of the capital that the French telegraph corps obtained its greatest success. During the fighting in the streets of Paris, in May, 1871, the moment a barricade was taken, a telegraph-station was established in a neighboring house, and when another post was carried the telegraph corps would again move forward with the troops, and thus MacMahon was able to watch every turn of the fight, and provide for every contingency, in a way that otherwise would have been utterly impossible. For ourselves, we have had no European war since 1854; but our armies have carried the telegraph with them into India and China, and through the ravines and passes of Abyssinia; and now the "talking wire" stretches from Cape Coast Castle through the bush, across the Prah into the heart of Western Africa, hanging on the trees, with here and there a few poles, the whole having been erected by Fantee laborers, under the direction of a handful of Royal Engineers.

The object of the field telegraph is to keep the headquarters of an army in communication with its several corps, and, at the same time, with the general telegraph system of the country. In the Prussian army, when the telegraph corps was reorganized after the war of 1866, it was formed into two divisions—the Field Telegraph Division and the Etappen Division—with a view to the more efficient performance of these two services. Both divisions consist of several companies or sections, each of which contains about 150 men, including officers, telegraph operators, pioneers, workmen for the erection of the line, and drivers for the station-, store-, and baggage-wagons. In all armies the telegraph *matériel* is, of course, very similar, and we shall therefore describe that of the Prussian army, adding a few notes on that of other countries.

The two essential portions of the field telegraph are the station and the line. In order that there may always be a sheltered place for erecting the instruments and transmitting messages, each detachment of the telegraph corps carries with it one or more wagons fitted up as stations; but, wherever a halt of more than a few minutes is made, and there is a suitable building available for that purpose, a telegraph-station is established in it by removing the batteries and instruments from the wagon. Fig. 1 is an outline sketch of a Prussian station-wagon, Fig. 2 being a section of the same. The wagon is about 9 ft. long, with an interior height of 4 ft. 6 in., and a width of 4 ft. It is

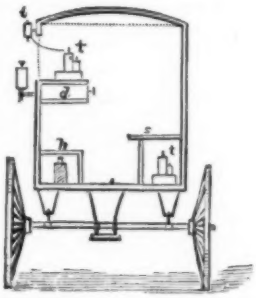
built as lightly as possible, and weighs when loaded only 14 cwt., and is easily drawn by two horses. On the outside are two insulated brass conductors *i* (Fig. 2), to which wires can be attached. Inside the windows is a shelf with a drawer *d*, on which the instrument *t* can be placed when in use, and opposite to this is a seat or bench *s* for the

Fig. 1.



Prussian Station-Wagon.

Fig. 2.



Section of Prussian Station-Wagon.

operators, on which a man can sleep at night. Under the seat is a recess in which a spare instrument *t* is kept, while the batteries are arranged in a box *b* under the shelf. When a message is to be sent from this movable station the wagon is stopped, and the line-wire is attached to the insulated conductor *i*. This is connected with the instrument and battery, and in order to complete the circuit the battery is placed in electrical communication with the second insulated conductor, to which another wire is attached which joins it to the earth-conductor or earth-stake (*piquet à terre*) (Fig. 5). Thus the course of the current, when transmitting a message, is from the battery to the instrument, and by the first insulated conductor *e* (Fig. 2) to the line of wire, the earth-plate of the receiving-station returning it to the earth-conductor, driven into the ground near the wagon, and thus back by the second insulated conductor to the battery.

The instruments are of the Morse pattern, constructed so as to fit in a very small space, and recording the signals with ink. The battery (of which there are two in each station-wagon) is a simple form of M. Marié Davy's sulphate-of-mercury battery. It consists of ten elements, one of which is shown in section in Fig. 8; *c* is a charcoal vessel, containing sulphate of mercury moistened with water to the consistency of paste, and in this the zinc plate *z* is suspended by means of the India-rubber cover I. The whole is placed in the India-rubber vessel *i*, and a copper collar *y* is added, to which a connecting wire can be attached. This battery has the advantage of being very portable, while the India-rubber cover prevents the charge of sulphate of mercury from being spilt by the motion of the wagon.

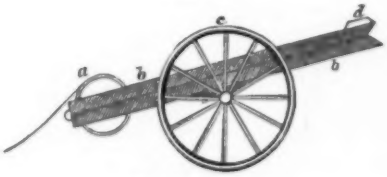
The line may be either an aërial or a ground wire, or a combination

of both, the former being stretched on poles, while the latter is insulated by being inclosed in a light cable, about half an inch thick, and laid along by the road-sides or across the fields. The uninsulated wire and the cable are both issued to the telegraph corps coiled on small drums, several of which are carried by each store-wagon. In those companies which are to erect a wire stretched on poles, the wagon carries five English miles of uninsulated galvanized iron wire, one mile insulated in gutta-percha, 1,000 yards of the cable, and 200 poles with insulators attached, all the wire being coiled on twelve

FIG. 3.

HAND-BARROW FOR UNCOILING WIRE.

FIG. 4.




WHEELBARROW.

drums. If it is intended to lay a ground-line, the wagon carries eleven drums of the cable, one of wire covered with a light coat of gutta-percha and tarred hemp, and a few poles and insulators, for carrying the line across small hollows, or raising it overhead in crossing roads. Beside these stores the wagon contains all the tools necessary for the work, and a light step-ladder is hung underneath it.

The wire is uncoiled from the drums by placing them successively on a hand-barrow, from which it is paid out as the barrow is carried along. The hand-barrow (Fig. 3) consists of a light iron frame, with wooden legs and handles, which are made to fold up when not in use. On this frame the drum *a* is placed; one man carries it in front and two behind, the wire uncoiling and running out between them. A wheelbarrow (Fig. 4) is sometimes employed, and is improvised for this purpose by attaching iron handles *d* to the step-ladder *b b*, and placing it on a pair of light iron wheels *c*, the drum *a* being hung in a socket near the top of the ladder.

The poles are made of well-seasoned and selected red pine, about 12 ft. long and a little more than an inch thick. At the bottom is an iron point for fixing them in the ground, and at the top a socket *s* (Fig. 6), of the same metal, with a hollow screw to receive the spindle or stem of the insulator. This consists of an iron spindle *b*, with a male screw cut in it, which supports either a cap of gutta-percha *g* or an earthen-ware cup surmounted by a metal bell. In both cases there is on the top of the insulator a metal hook *a*, in which the line-wire is hung. There are also insulators, the spindles of which terminate in spikes or sharp screws for driving into walls and trees, thus saving the trouble of erecting a post (Fig. 9).

When all the wire of the first drum is laid down, the end of it is roughly spliced on to the wire of the next drum, and the joint secured by means of the conductor (Fig. 7). This consists of two semi-cylindrical pieces of hard wood *a*, their flat side being grooved to receive the wire, and covered with a layer of India-rubber *b* to act as packing, and insulate the joint, in the case of a ground-line, and the whole is held tightly together by the brass collar and screw *c c s* (Fig. 8).

The line is very rapidly and easily constructed. In the case of a ground-line it is simply paid out from the drums on the hand or wheelbarrow, being buried in a shallow trench or elevated on poles, when it is necessary to cross a road, where the insulation of the cable might otherwise be injured by the wheels of passing vehicles. During the invasion of France the Prussians frequently avoided the roads in order to protect the line from the *franc-tireurs*, and made considerable *détours*, concealing it in woods, ravines, and water-courses. Where the uninsulated wire is used, poles are erected about fifty paces apart, the hole to receive each pole being made by driving a sharp pointed iron bar into the ground with a heavy mallet. As soon as a pole is fixed the wire

FIG. 5.

EARTH-CONDUCTOR.

is run through the hook on the top of the insulator, and stretched tight by a man holding it over his shoulder, who keeps it in this position until the next pole is ready to receive it. Wherever there are trees or walls near the line, the work is still further lightened by dispensing with the poles, and merely attaching the wire to the insulators specially constructed for this purpose. In this way the line was erected for the Ashantee expedition, the negro laborers carrying only a light ladder to ascend the trees, a small axe to clear away the boughs, and a gimlet to make a hole for the spindle of the insulator. It never took, we are informed, more than five minutes to fix an insulator to a tree; but, in those few places where trees were not available, fully half an hour was occupied in erecting each pole, and even then it was often unsteady, and had to be propped and guyed.

In Europe, where there is an extensive telegraph system in operation in every country, there is no need of the field telegraph-lines extending from the front of the army to the base of operations. Far less than this is required. All that is necessary is to connect the headquarters of the army with the nearest point on a permanent telegraph-line, and in most European countries an army in the field would seldom, if ever, be more than ten miles from such a line. Ten miles of the field telegraph can easily be erected in half a day; indeed, the

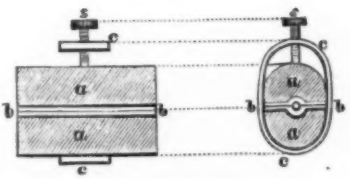
Austrian engineers assert that on favorable ground they could do the work in two hours. In most cases, of course, the advancing army would have to repair the permanent lines which would be partially destroyed by the retreating forces, and in this way twenty-five miles of wire were often erected by the Prussians in a single day. As soon as an army moves forward, the field-telegraph line previously erected is taken down and recoiled on the drums, while a fresh line is laid from the new headquarters to the nearest permanent telegraph. This is done with a view to economizing the material, an enormous amount of which would have to be carried with the army, if the lines it left behind it in its advance were not removed, and the poles, wire, and insulators, employed in their construction again utilized. The hand-barrows of the Austrian telegraph corps are designed to be used in recoiling as well as uncoiling the wire; and for this purpose are fitted with a crank-handle and ratchet-wheels, so as to enable a man to turn the drum and wind the cable upon it.

Besides the ordinary field-telegraph companies, the French army includes a mountain-telegraph corps, organized with a view to opera-

FIG. 6.

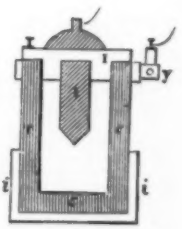
TELEGRAPH-POLE, SOCKET, AND INSULATOR.

FIG. 7.




WIRE-CONNECTOR.

FIG. 8.




MARIÉ DAVY BATTERY.

tions on the mountainous frontiers of the south, or to be ready to carry a line over a range of hills in an ordinary campaign, thus avoiding a long *détour* in the valleys, or securing lateral communication with troops divided from the main army by the hills. As the mountain line would have to be laid along narrow, rocky paths, and through lofty passes, all carriages and wagons are dispensed with, and their place is taken by a train of mules. In a mountain-telegraph company several of the mules are each laden with two drums of the insulated cable, the instruments and batteries are carried on pack-saddles on the backs of others, and others again transport the baggage, provisions, and forage of the company, and also a light tent to form a station whenever messages are to be sent along the line.

While the field telegraph affords a commander a rapid and certain

medium of communication with his base of operations and the various corps of his army, it must be remembered that it is one which is continually liable to interruption by an enterprising enemy. Wherever a general has to contend with an army well provided with good cavalry, he will find it extremely difficult to protect his telegraph-lines from being destroyed by daring raids of his opponents. There are several easy ways of making a telegraph-line temporarily useless. The simplest and most obvious method is to pull down the poles and cut the wires into pieces; but when this is done the damage is easily detected,

FIG. 9.

THE FIELD TELEGRAPH.—*a a a*, line-wire supported on posts and tree; *b*, station-wagon; *c*, earth-conductor.

and the repairs at once commenced. The interruption will, therefore, be far more serious if it can be effected in a way which will not permit of its exact locality being so readily discovered. This can be done by cutting the wire, introducing a piece of gutta-percha, or any other non-conducting substance, into the course of the circuit, and connecting the ends of the wires with it, so as to give it the appearance of one of the ordinary joints or splices of the line. At the same time a few poles can be pulled down in another place, and the wires cut, and the probability is that the engineers who repair the line will not discover the hidden interruption of the circuit until after they have restored the gap, and found that the wire is still cut somewhere else, and even then the place where the non-conducting substance is introduced will not be discovered until some time has been employed in carefully testing the line with the galvanometer.

But there are other dangers to telegraphic communication in the field besides the mere damage to the line. If the enemy's cavalry get possession of a station, they can easily send messages containing false information or delusive orders to well-known officers of the opposing force, while the place from which they are sent, and the assumed name in which they are dispatched, will give the messages an appearance of authenticity which, if it does not completely deceive the recipient, will at least be the cause of considerable doubt and perplexity to him, and perhaps make him hesitate to accept the accurate information or authentic orders received from other sources. Again, even without occupying a station, it is possible to read the messages which are passing along a telegraph-line, and thus perhaps discover important secrets. All that is required for this purpose is a small portable receiving instrument, and a few yards of copper wire to connect it with

the line. A single individual, thus equipped, can "tap" a telegraph-line, in the daytime, by receiving the message in the ordinary way; and at night (when, of course, it would be easier to approach the line) by listening to the clicking of the armature against the electro-magnet of the instrument. But all these dangers are only of a partial or temporary character. By carefully patrolling and testing the line, it cannot be interrupted for any length of time without the damage being observed and repaired. By adopting a secret arrangement that there shall be a certain number of letters in the two or three words at the beginning or end of every message, a dispatch sent by an enemy can, in most cases, be detected; and again, by employing a cipher alphabet, it will be difficult for any one who taps the line to obtain information from the messages which fall into his hands.

From this brief sketch of the structure and uses of the field telegraph, the reader will understand what an important part it plays in modern warfare. On the march it directs the movements of advancing columns, on the battle-field it flashes orders and information with the speed of thought to right, centre, and left, of the immense lines extended over mile after mile of country; in beleaguered cities it places the whole defense from moment to moment under the eyes of those intrusted with its direction, and it is of no less value in the attack. It is not too much to say that, without this wondrous power, it would be almost impossible to direct the movements of the thousands on thousands of men, and guns, and horses, which form the vast armies of Continental Europe. It has effected a revolution in military science, none the less important because it is hidden from the general view, and seldom attracts the attention of even the ubiquitous special correspondent. Armed with all the weapons which inventive genius and mechanical skill can devise, the modern commander has the lightning also to do his work, and the electric current gliding on its secret path through the wide net-work of cable and wire tells him what is passing each hour in the remotest parts of the theatre of war, and transmits the mandates which decide the fate of nations.—*Popular Science Review.*

## HINTS ON THE STEREOSCOPE.

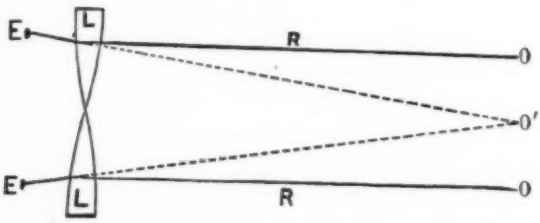
By FRANKLIN C. HILL.

THE following diagrams will help to explain the principle on which this instrument acts. The stereoscope-glasses are halves of the same lens, placed with their outer edges toward each other (*L L*), Fig. 1. Rays of light (*R R*) from the objects (0 0), striking the oblique surfaces of the lens, are refracted outward, toward the focus, and thus reach the eyes (*E E*) in an oblique direction, appearing to come from

(0′), a point half-way between the objects. Each eye being thus deceived, the objects seem to be one.

This may be easily demonstrated by drawing on the plain back of a stereograph two similar circles, one with an horizontal and one with a vertical diameter, opposite the centres of the pictures, and, half-way between them, a heavy vertical line (as in Fig. 2). Then, looking at the card through the instrument, a circle will appear with *crossed* diameters, and with a vertical line on each side (as in Fig. 3).

Fig. 1.




By closing and opening the eyes alternately, the diameters and vertical lines will appear and disappear, but the circle will remain constant. The right eye is thus deceived into seeing the circle in the middle, and the line away to the left; and the left is deluded on the other side. The same effect may be quickly obtained by sticking a common pin upright on the middle of the rack, with a carpet-tack on each side, when a tack will be visible standing between two pins.

In selecting a stereoscope, first look that the glasses be large and heavy, and of perfectly clear glass, and see that they are wide enough

Fig. 2.

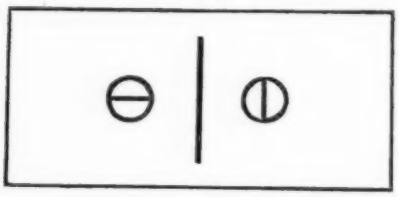
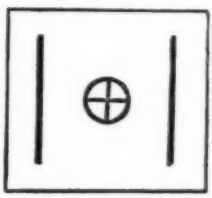


Fig. 3.



for the eyes to come opposite the middle of them, producing no feeling of being shut in by dark objects at the side. Many instrument-makers seem unaware that heads differ in width.

Then, placing a picture in the rack, see that the diaphragm hides no part of it when the rack is drawn up to a short focus. Near-sighted people have rights as well as others. Should the pictures not appear as one, remove the card and stick up a pin on each side of the rack equidistant from the middle, moving them in or out until they appear as one. If the pins have to be within two or two and a half inches

of each other to "solidify," reject the instrument; but, if they meet well when farther apart, the fault was in the pictures.

A friend complained to me that the stereoscope she had bought, on my recommendation, was worthless. I had taken it on faith, supposing that all "Holmes" instruments must be good; but a short examination showed that the glasses were rather flat, and were placed so near together that the rays came to the eyes through the central part of the lens, and of course without refraction, and hence the eyes were not deceived. By whittling out the frame, and moving each glass outward about three-eighths of an inch, a good instrument was made.

If a view does not "stand out well" when seen in a good instrument, examine each picture by itself, and try to find a well-defined object, as a post or tree, in the foreground, and note its relations to some other object in the distance. If the two objects have the same relative position in both, the pictures are duplicates, and worthless.

If the distant object is to the right of the near one, they should appear farther apart in the right-hand picture, and *vice versa;* if not so, the pictures are mounted on the wrong ends of the card, and are worthless, or worse.

## THE CHAIN OF SPECIES.[1]

By Hon. LAWRENCE JOHNSON.

### Part I. — *Science and Religion.*

THE subject selected for this evening's entertainment—the evolution and metamorphoses of organic forms, from the genesis of life up to man—with all its difficulties, might, in skillful hands, be made amusing; but, let us rather hope for the earnestness, however dull, which will instruct, instead of the light talent which can while away an idle hour. It is a subject which has escaped from the pinfold of the learned, and become public property, at least in part; and we see it engaging the attention of news-mongers, writers of squibs, and makers of woodcuts, as well as the graver interests of literary circles, and the thunders of the pulpit.

And here let us pause a little to place ourselves right with ourselves, and right with the rest of the world.

As it is proposed to view this matter, there is not one particle of religious interest in it, any more than there would be in a lecture on geology, chemistry, or any other pure science; and, in the name of truth, system, and logic, I must protest against the unscientific, un-

[1] An address, delivered before the Franklin Society of Mobile, June 4, 1872, by Hon. Lawrence Johnson, of Holly Springs, Mississippi.

philosophical, and irreligious manner in which sacred subjects and questions are lugged into this controversy.

Science deals only with the laws of Nature, with *secondary* causes only, and can never extend to *first* and *final* causes; not that these are denied, not that the supernatural is contemned, either explicitly or by implication; he is a shallow scientist that will do so; on the contrary, the supernatural, in its true sense and position, will be assumed—*the supernatural*—that which is above—a higher than Nature, not contrary thereto, nor ever to be separated from it. "Within Nature, but not included; without, but not excluded; above it, but not taken away; underneath, and not a mere support, nor derived from it."[1] Yet it is well, and even necessary, to be sure of a safe footing upon the earth, before we lift our eyes unreservedly to the heavens.

Socrates once desired to see the day "when Nature would be explained by reason alone." This is the end and aim of all philosophy: to render all we see, and know, and think, and do, rational; to obtain rational conceptions for all things. But, remember what *explanation* is. No explanation removes *all* difficulties; solves all mysteries. Properly considered, none pretends to such a thing. Explanations only connect the unknown with the better known; the less familiar with the more familiar; new, unarranged phenomena, or ideas, with old classified facts. All classification, all science, consists of this correlation of ideas.

Now, if the scientist confines himself to the correlation of physical facts, he cannot encroach upon the domain of religion, which is devoted to supernatural beliefs and hopes; yet a skeptical religionist is always craving for some physical facts to strengthen his faith, and the superstitious scientist is always afraid of meeting with miracles. How utterly both are mistaken! No amount of wonders would impart faith to a soul already filled with doubt; nor would the scientist have the least alarm on the subject of miracles and cataclysms if he understood truly the finite and the infinite, the Creator and the creation, the reign of eternal and universal law! In going around the circle of mere cosmical relations, time and space, man finds himself bounded by the great impassable and incomprehensible Unconditioned—eternity—ubiquity. And in vain the half-learned, and all not fond of exertion, because they cannot easily comprehend the relations of the finite and the infinite, rush to the conclusion that they are in conflict, and irreconcilable; so that, in the popular mind, the human and the divine, reason and the imagination, our doubts, and hopes, and fears, have become much entangled, and like "sweet bells jangled, out of tune and harshly."

It has been beautifully remarked of the perplexing contradictions

[1] "*Supernaturale igitur, perficit quidem et elevat Naturam, non vero illi contrarium esse potest*" (The supernatural perfects and elevates Nature, but cannot be contrary thereto). (Branchereau, "Ontology," § 11, p. 6.)

often discovered in circumstantial evidence, "We only have to get hold of the right end to be able to unwind the mystery as you would a skein of thread." Nor is the narrow fear of conservative religionists to be too harshly blamed for this misapplied and unnecessary warfare. The windmills are certainly there, although they are not giants.

Filled with natural vanity at the discovery of some new fact of this wondrous life, or arrived at some new aspect of it, some new view of Nature, such pride as stirred the soul of Nuñez de Balboa when, first of civilized men, from the Cordillera of Panama, he caught sight of the great South Sea, is not unbecoming the pioneers of thought and knowledge. The danger to be guarded against is the common one of all vanity, that of mistaking partial attainment for complete victory, the achievement of a stand-point in advance assumed as the only possible one. The error is that of forgetting, like that same first beholder of the Pacific, that the apparent trend of coast depends upon the simple fact of position, the stand-point. And like him, also, it is natural, easy, and common, to conclude that the opening of some petty gulf before us is the grand expanse of the boundless ocean.

Coming in plain terms to the point before us: When a naturalist, confining himself properly to reason and the laws of Nature, speculates on the origin of species, and attempts to show the correlation of form to form, the evolution of one from another, or the development of many distinct species from a common stock, the reverence of certain minds, which have long run in a certain groove that connects these obscure mysteries of Nature with some imagined interference of Omnipotence, is seriously shocked. These, looking only to primary and final causes, feel contempt for the laborer who is working, for his penny a day, for the sight of the *next* step in that endless chain of secondary, efficient causes, which is the revelation of Nature to the rational faculty.

On the other hand, the proper conservatism of religious minds is often insulted by the exclusive cultivator of mere natural science, as the reserve and resistance of ignorance and fanaticism. Vainglorious in the light of some new discovery, he sees all the rest of the world in apparent darkness. If each—the worshiper according to the old faith, and the cultivator of the new science—understood the domain of the other better, the conclusions of both would be different.

Nor is it a few tyros in science who thus forget their true vocation, and invade a province they do not understand. When we find a Spencer and a Huxley leveling their wrath, like ordinary zealots, against what they style anthropomorphism, and issuing bulls of excommunication from their self-constituted Church of Common-Sense, against all who differ with them, against all who dare to believe in what they call the "dogma of special creations"—and even Charles Darwin, most moderate and dignified as he is of all scientists, acknowledges that "the object of his earliest work was, to combat this same

dogma"—it must be admitted that the religious have grounds to fear that implacable war is to be waged against them.

Those who stand on the heights of genuine faith cannot be disturbed by such misguided attacks. Being up in the mountain of vision with the Lawgiver, they take no note of those at the base, who make golden calves for gods. But we are not all as secure in our faith as the prophet, who, according to the legend, talked with God, while none of us are without some religiosity. Where faith is only an opinion, it is not unmixed with doubt; and where there is doubt there is also fear; and anger and fanaticism are only doubt and fear applied. As the poet tells us:

> "There is no philosopher but sees
> That rage and fear are one disease."

Our popular theologians, then, whose notion of faith is opinion, and their cherished doctrines only collections and conglomerations of opinions, may well be excused for the alarm they exhibit at the assumptions of the new lights who boast themselves the disciples of reason alone, and the possessors of a positive philosophy, definite, clear, and certain.

Now, who would imagine, after all this mustering of forces, that there is not a shadow of foundation for the conflict which is so fiercely waged?

If we liken the half-armed advocates of religion, in their heterogeneous harness, to the gallant knight of La Mancha running a tilt with the windmills, we are not the less reminded of him when we witness the triumph of the new philosophers at the overthrow of the "dogma of special creations." Here, indeed, we see exemplified, also, *mutatis mutandis*,[1] that other exploit when the famous representative of chivalry swooped down upon the frightened barber and captured his pewter basin for Mambrino's helmet. In attacking and carrying off this "dogma of special creations," they have made war upon a figment of their own brains, or, at most, upon the unphilosophical, and therefore unscientific and irreligious fictions of gentlemen of their own school. Where faith is wanting, superstition and credulity abound. Strange! strange! I repeat. There is no such doctrine as that of "special creations," such as they set out in their travesty under that head, contended for as a dogma by any school of religion, pagan, Jew, or Christian.

The anthropomorphic legends and poems of infant races, necessarily anthropomorphic because poetry, which is always simple, sensuous, passionate, are not formal enunciations of rational dogma. At most they contain only the philosophy of the religion (enveloped, and therefore concealed as well as revealed), under sensuous—that is, poetic—images.

[1] The necessary changes being made.

We shall expect these new iconoclasts next to make war upon our nursery-rhymes. We cannot doubt they will soon insist upon calling on the babies to announce to them that there is no such person as Mother Goose; or bring up syllogisms in mood and figure to overthrow the dogma of Santa Claus. The sophomores are not confined to the lower classes in our colleges! Truly our age may be described as a post Santa Claus period—the age of our first pair of pantaloons. A little out of mere infancy and thoughtless trust, and not yet arrived at clear rational and moral ideas—not yet reached the "years which bring the philosophic mind." We are in a betwixt and between condition when we still eat our Christmas candy with childish gusto, but begin to suspect shrewdly that papa and mamma had something to do with filling the stockings. We do not exactly know, but our very superstition and doubt drive us to endeavor to find arguments to combat the story which once filled our childish imaginations with delight.

There is one point, then, we may set ourselves easy upon, and claim reconciliation with the rest of the world: There is no such dogma as that of special creations, announced as a systematic article of faith by any religious authority; nor philosophically discussed and contended for by any theologian worthy of the name. A few unwary ones, like Hugh Miller, more skilled in rocks than in the theology in which he thought he believed, may, now that the question is raised, have confounded the Genesis of Species with the more general idea of Creation; and may have followed their antagonists into blunder after blunder.

It is no reply to this position to point out the fact that eminent religious teachers, such as Balmez, or even St. Augustine, at times spoke of the creation of species. For that matter, it is not unphilosophical to speak of the creation of individuals, and that with the instrumentality of immediate parents before our eyes. But, granting these to be mistakes of said doctors of theology, nothing is concluded thereby. For even our lawyers in the ordinary practice of the courts will tell you that *obiter dicta* of a judge decide no law. Innumerable instances occur in their daily practice when the judges, declaring and announcing correctly the general principles of law, yet make the most absurd and illogical application to particular facts and cases, and that even on points actually before the court; much more upon questions only incidentally brought in upon their own motion. Hence the general rule of logic in such matters: that general rules take precedence of particular applications.

The same rule applies here: for it is fact that this question, exactly as we now put it, never was before the court until formally raised in this plea of evolution.

But, to go back through the literature of the case: From very remote periods, even of Greek philosophy, discriminating analysis is

compelled to discover that the question is not so much of a creation, as of a rational conception of the creation—not of the fact, but of the method.

Religious faith does step in, where science fails, to say how the Cosmos began, and is ordered and sustained in perpetual harmony. Physical science, of course, has nothing to do with first and final causes, and therefore answers: "We cannot tell whether the Cosmos is eternal, or began in time." It is a higher philosophy that comes in to answer, with the irresistible definitions of a higher logic, that it began in time. According to the very terms of the proposition, matter is bounded by space and time, and exists only in, by, and through these limitations. Consequently, it is even a contradiction in terms to ask the question, whether it is eternal or not. It is the same absurdity as to ask if the finite be infinite; if the limited be ubiquitous; if the conditioned be unconditioned.

Again: Religion, sustained also by a true philosophical ontology, asserts that the relation of the infinite to the finite—of the eternal to the limited—is that of a Creator. For, if this is not so, then they must be of the same substance—that is, identical, which again is absurd by the very terms of the proposition.

Having the creation—the basement-matter—let us proceed to its metamorphoses. And here, coy as sea-born Thetis, it will take the valor, the skill, and the passionate pursuit of heroes worthy to wed immortal brides, to follow Nature through her protean form and into her concealed recesses.

These metamorphoses depending upon the elements of the Cosmos —upon the laws with which matter is endowed (and it would not be matter, remember—this Cosmos which we know—without them)—the investigation is strictly, and without the least irreverence, the legitimate province of rational physical science. It is as religiously a duty to make use of the reason to comprehend and "justify the ways of God to man," as it is, through faith and love, to adore him.

The *method* of creation, then, it is, and not the *fact*, that natural science deals with. It invites our attention to physics, simply, and leaves metaphysics to a higher school.

When, therefore, these doctors of the new school tell us that they are about to overthrow religion in one of its old dogmas—namely, as they define it themselves, that the Creator came here, and, like a potter upon his wheel, out of distinct lumps of clay, in certain definite periods, produced certain definite forms, which forms, in organic creatures, are species, and which may perish or endure, but cannot change—it is easy to see that they have not themselves risen above that anthropomorphic conception of Deity which they assume to condemn. They are still struggling with eyes half open to realize whether it is Santa Claus or papa in his nightcap. In a word, they have not arrived at the conception of the Creator as infinite and eternal, and that his acts are

in eternity, not in time. Nor have they a conception of a creation by law—a creation through the Logos—that eternal Reason, that all-providing Wisdom—whose hand stretched the line upon it, and whose right hand held the plummet; a scintilla of which enlightens every man that cometh into the world. Talk of their bringing forward this doctrine of evolution as a new discovery! They have, indeed, elaborated it in many new applications, but, as to the doctrine itself as a new proposition in philosophy, it was already old when Pythagoras was a school-master. Evolution new in philosophy, and the poetic or anthropomorphic notion of special creations a dogma of theology! Why, we are almost tempted to believe, with the satirist, that "nowadays men read every thing but books!" Even the (so-called) narrow-minded, ignorant schoolmen of the dark ages (very dark to those who consult not the numerous authors of the period)—even these made a broad distinction between the act, so to speak, the moment which called matter into existence, and that which merely modifies its forms and appearances. The former they dignify with the supreme title, creation (*creatio*), while the latter they called eduction or evolution (*eductio*). Looking to the continuance of the creative energy, and yet according to the law—according to, and by, definite and fixed properties, so to speak, with which matter is endowed—the term *eduction* is generally preferred by them; but *evolution* is also used for the same thing indifferently. And a late author, but of the same school in metaphysics, summing up their cosmological doctrines, and showing a reconciliation of the controversy concerning the relation of the Creator to the universe, from their point of view, known as the doctrines of harmony and assistance, says that the advocates of the latter doctrine taught that "God works not in his creation except according to the constant and general laws determined from the beginning" (Branchereau, "Cosmology," p. 70). And the still more general doctrine, also maintained by them, that "all beings admit of evolution by gradations to perfection according to their several natures," goes as far as Mr. Spencer, or any other philosopher, has gone, in the enunciation of general principles on this subject, and from a more elevated position (Branchereau, "Ontology," p. 56).

This very fact, that the highest theological philosophers and doctors, from St. Augustine down to our own times—as shown by Mr. Mivart and others—have never had any difficulty on the subject of the abstract question of the creation of the Cosmos, and the eduction of infinite variety from primordial matter by and according to constant law, however ignorant the same authors may have been of facts in Nature, and however jejune their notions of history and physics, ought to be sufficient to quiet us as to the legitimacy of our investigations; in short, that there is no more danger to orthodoxy (as the word is) in this endeavor to discover and trace the steps and stages of the development of life, than there is in the application of chemistry to the

analysis of minerals, of geology to the classification of the earth's strata, or of astronomy to the calculation of the motions and relations of the heavenly bodies.

Nor is there any more mystery in one than in the other. Of course, in biology, the process is more complicated—more difficult to comprehend—but not incomprehensible. Indeed, as will be seen at the proper time, the mysteries of daily occurrence, such as growth, budding, and reproduction, are as great as any which beset the passage from form to form, from species to species. No one who has thought of it sufficiently can deny that the ordinary facts of generation, as the necessity of the union of two cells of nearly-spent vitality to produce a third cell, or a brood of cells, endowed with primeval vigor, present difficulties more unsurpassable than the origin of the germs of living things from inorganic matter; or that the preservation of species, by like producing like, is more difficult of explanation than the beginning of new species by variations in the reproduction, which, as a fact, is more likely to occur than the resemblance. The genesis of life from the inorganic kingdom we can begin to comprehend, because it is more simple and can be referred to known physical forces; but the other —that is, reproduction—is still wrapped in impenetrable obscurity.

A glance at the history of this controversy will make the whole matter clear, and, as remarked, ought to set us right with the rest of the world.

In the dawn of science as we know it—that is to say, in the rise of the Greek philosophy—no other view of creation was thought of than that which modern induction now demands, because, happily for them, there was not in their possession any supposed revelation on the subject, and there was no school which thought of any other solution of the problem than one which could be deduced from observation and speculation. Yet they suggested little that would now be of benefit, the range of their facts and of their analysis being too much limited.

The moderns, notwithstanding that the general principles of the philosophy, and of the philosophical theology of the middle ages were, as we have seen, favorable, have cramped and trammeled themselves with many irrelevant matters. The so-called skeptics are not alone to blame for the unnecessary conflict existing between Religion and Science. In the great religious revolutions of the sixteenth century (incident to revolutions in empire and commerce), from the excitement of religious parties theology and polemics assumed the lead in literature and thought. And such was the increased importance given to individual opinion, arguments, and scholarship, that it is often difficult to separate the idiosyncrasies of the author from the general cause he advocated. In their appeals to history as the principal method of discussing divinity, it was natural that each scholar should, consciously or unconsciously, adopt some scheme of universal history; and it was

also natural that there should be an almost universal concurrence in their views of primitive times, because there was nothing in their disputes about the dogmas of Christianity to bring the early ages of man and of the earth into discussion. When, therefore, the skeptics, in their profound ignorance of theology and of the higher philosophy, ran against these sand-bags of individual opinions, it was natural for them to suppose that they had discovered the very citadel of religion; although, as we have seen, these anthropomorphic schemes are no more like religion than the play-house earthworks of children, piled up some summer's day on the sandy shore, are like Fort Morgan. Yet, from this simple psychological connection in their growth, history, science, and theology, since that period have been polemical; and, when, by the application of truly rational and scientific methods, thinking men began to construct the natural history of the earth from the facts recorded in the strata of its crust, and it began to be seen that all organic forms are modeled upon one common plan and developed out of primordial types under the operation of natural laws, an alarm was sounded, as if the principles of Faith were really involved, and in danger of impending overthrow. In their alarm and trepidation the guardians of the dimly-comprehended regions of Religion, regarding all who wander out of the beaten paths of knowledge as "false knaves," begin their examinations always, like a certain famous magistrate, with the question, "Masters, do you serve God?" and insist that "God" shall be written first, "for God forbid but God should go before such villains."

On the other hand, again, as remarked, there are scientific men who would also be philosophers, who suppose the anthropomorphic, that is, the poetic expressions of religious conceptions, to be essential to and the very gist of worship. Not having arrived at any thing beyond anthropomorphic notions of the Deity themselves, they weakly imagine that no other are possible; that there is no religion, no religious worship, nothing to lift man out of and beyond himself into the contemplation of the unexpressed sublimities of the Infinite and the Almighty, except the legends of the miracles and wonders of remote ages. Hence one of them now boasts that, in the advance of science, "anthropomorphism" (by which he means religion itself) "is driven to its last intrenchment—the mind and heart of man himself." When was it ever anywhere else? When was it ever any thing else (that is the expression of it) than a development of the imagination—the faculty of faith—the æsthetical faculty—that which lifts man above the clods of earth and makes him akin to the immortal and the divine? For is not religion both a science and an art?—from the inductive point of view as truly a science as any other, and the climax and crowning glory of all the others? and also an art, a fine art, as truly as any other, and the most divinely beautiful of them all?

Alas for the philosopher who thinks it driven to the last ditch!

He confesses his defeat when he sadly admits this last intrenchment impregnable; for here, he says, "it must ever remain a drawn battle." Rightly understood, not a drawn battle, but a victory to Religion, the possessor of the citadel—a victory which grows more and more decisive the more it is perceived that the "mind and heart of man himself" is the only territory it ever claimed—the only dominion it ever attempted to defend. After all, is not the simple admission of a devout mind, when it meets with some inexplicable fact—"God made it so"—more philosophical than the shallow assertion of presumptuous science, "We can never know?"

## CLIMATE AND SOCIAL DEVELOPMENT.[1]

By HERBERT SPENCER.

LIFE in general is possible only between certain limits of temperature; and life of the higher kinds is possible only within a comparatively narrow range of temperature, maintained artificially if not naturally. Hence it results that social life, presupposing as it does not only human life, but that life vegetal and animal on which human life depends, is restricted by certain extremes of cold and heat.

Cold, though great, does not rigorously exclude warm-blooded creatures, if the locality supplies in adequate quantity the means of generating heat. The arctic Fauna contains various marine and terrestrial mammals, large and small; but the existence of these depends, directly or indirectly, on the existence of the inferior marine creatures, vertebrate and invertebrate, which would cease to live there did not the warm currents from the tropics check the formation of ice. Hence such human life as we find in arctic regions, dependent as it is mainly on that of these mammals, is also remotely dependent on the same source of heat.

Here the fact we have to note is that, where the temperature which man's vital functions require can be maintained with difficulty, social evolution is not possible. There can be neither a sufficient surplus power in each individual nor a sufficient number of individuals. Not only are the energies of the Esquimaux expended mainly in defending himself against loss of heat, and in laying up stores by which he may continue to do this during the arctic night, but his physiological processes are greatly modified to the same end. Without fuel, and, indeed, unable to burn within his snow-hut any thing more than an oil-lamp, lest the walls should melt, he has to keep up that bodily warmth which even his thick fur dress fails to retain, by devouring vast quan-

[1] From advance sheets of the "Principles of Sociology.—Part I. The Data of Sociology. Chapter III. Original External Factors."

tities of blubber and oil; and his digestive system, heavily taxed in providing the wherewith to meet excessive loss by radiation, supplies less material for other vital purposes. This great physiological cost of individual life, indirectly checking the multiplication of individuals, arrests social evolution.

A kindred relation of cause and effect is shown us in the Southern Hemisphere by the still more miserable Fuegians. Living nearly unclothed in a region of continual storms of rain and snow, which their wretched dwellings of sticks and grass do not exclude, and having little food but fish and mollusks, these beings, described as scarcely human in appearance, have such difficulty in preserving the vital balance in face of the rapid escape of heat, that the surplus for individual development is narrowly restricted, and, by consequence, the surplus for producing and rearing new individuals. Hence the numbers remain too small for exhibiting any thing beyond incipient social existence.

Though, in some tropical regions, an opposite extreme of temperature so far impedes the vital actions as to impede social development, yet hindrance from this cause seems exceptional and relatively unimportant. Life in general, and mammalian life along with it, is great in quantity as well as individually high, in localities that are among the hottest. The inertness and silence during the noontide glare in such localities do, indeed, furnish evidence of enervation; but in cooler parts of the twenty-four hours there is a compensating energy. And if it is true that varieties of the human race, adapted to these localities, show us, in comparison with ourselves, some indolence, this does not seem greater than, or even equal to, the indolence of the primitive man in temperate climates.

Contemplated in the mass, the facts do not countenance the current idea that great heat hinders progress. Many societies have arisen in hot climates, and in hot climates have reached large and complex growths. All our earliest recorded civilizations belonged to regions which, if not tropical, almost equal the tropics in height of temperature. India and Southern China, as still existing, show us great social evolutions within the tropics. And, beyond this, the elaborate architectural remains of Java and of Cambodia yield proofs of other tropical civilizations in the East; while the extinct societies of Central America, Mexico, and Peru, need but be named to make it manifest that in the New World, also, there were in past times great advances in hot regions.

It is thus, too, if we compare societies of ruder types that have developed in warm climates, with allied societies belonging to colder climates. Tahiti, the Tonga Islands, and the Sandwich Islands, are within the tropics; and in them, when first discovered, there had been reached stages of evolution that were remarkable considering the absence of metals. So that, though excessive heat hinders the

vital actions, not only of man as at present constituted, but of the mammalia generally, such heat hinders the evolution of bodily energy only during part of the day, and, by the abundance of materials for living which it fosters, aids social development in most ways more than it impedes it in some ways.

I do not ignore the fact that in recent times societies have evolved most, both in size and complexity, in temperate regions. I simply join with this the fact that the first considerable societies arose, and the primary stages of social development were reached, in hot climates. Joining these two facts, the entire truth would seem to be that the earlier phases of progress had to be passed through where the resistances offered by inorganic conditions were least; that, these phases having been passed through, and the arts of life having been advanced, it became possible for societies to develop in regions where the resistances were greater; and that further developments in the arts of life, and further discipline in coöperation going along with them, enabled societies inheriting the resulting advantages to take root and grow in regions which, by climatic and other conditions, offered relatively great resistances.

Taking the most general view of the facts, we must therefore say that, solar radiation being the source of those forces by which life, vegetal and animal, is carried on, and being, by implication, the source of the forces displayed in human life, and consequently in social life, it results that there can be no considerable social evolution on tracts of the earth's surface where solar radiation is very feeble. We see that, though, contrariwise, there is on some tracts a solar radiation in excess of the degree most favorable to vital actions, yet the consequent hindrance to social evolution is relatively small. Further, we conclude that an abundant supply of light and heat is requisite during those first stages of progress in which social vitality is small.

Passing over such traits of climate as variability and equability, whether diurnal, annual, or irregular, all of which have their effects on human activities, and therefore on social phenomena, I will name here one other climatic characteristic that appears to be an important factor. I refer to the quality of the air in respect of dryness or moisture.

Either extreme brings indirect impediments to civilization, which we may here note before observing the more important direct effects. That great dryness of the air, causing a parched surface and a scanty vegetation, negatives the multiplication needed for advanced social life, is a familiar fact. And it is a fact, though not a familiar one, that extreme humidity, especially when joined with great heat, may raise unexpected obstacles to progress; as, for example, in some parts of East Africa (Zungomero), where, according to Captain Burton, "the springs of powder-flasks exposed to the damp snap like toasted

quills; . . . paper, becoming soft and soppy by the loss of glazing, acts as a blotter; . . . metals are ever rusty; . . . and gunpowder, if not kept from the air, refuses to ignite."

But it is the direct effects of different hygrometric states which must here be more especially set down—the effects on the vital processes, and therefore on the individual activities, and, through them, on the social activities. There is good reason, inductive and deductive, for believing that the bodily functions are facilitated by atmospheric conditions which make evaporation from the skin and lungs tolerably rapid. That weak persons, whose variations of health furnish good tests, are worse when the air, surcharged with water, is about to precipitate, and are better when the weather is fine, and that such persons are commonly enervated by residence in moist localities but invigorated by residence in dry ones, are facts generally recognized. And this relation of cause and effect, manifest in individuals, is one which we may suspect holds in races—other things being equal. In temperate regions, differences of constitutional activity due to differences of atmospheric humidity, are less traceable than in torrid regions, the reason being, that the inhabitants are subject to a tolerably rapid escape of water from their surfaces, since the air, though well charged with water, will take up more when its temperature, previously low, is raised by contact with the body. But it is otherwise in tropical regions where the body and the air bathing it differ much less in temperature, and where, indeed, the air is often higher in temperature than the body. Here the rate of evaporation depends almost wholly on the quantity of surrounding vapor. If the air is hot and moist, the escape of water through the skin and lungs is greatly hindered; while it is greatly facilitated if the air is hot and dry. Hence, in the torrid zone, we may expect constitutional differences between the otherwise-allied inhabitants of the low, steaming tracts and the tracts which are habitually parched with heat. Needful as are cutaneous and pulmonary evaporation for maintaining the movement of fluids through the tissues, and thus furthering molecular changes, it is to be inferred that, other circumstances being alike, there will be more bodily activity in the people of hot and dry localities than in the people of hot and humid localities.

The evidence, so far as we can disentangle it, justifies this inference. The earliest recorded civilization grew up in a hot and dry region—Egypt; and in hot and dry regions also arose the Babylonian, Assyrian, and Phœnician civilizations. But the facts when stated in terms of nations are far less striking than when stated in terms of races. On glancing over the rain-map of the world, there will be seen an almost continuous area marked "rainless district," extending across North Africa, Arabia, Persia, and on through Thibet into Mongolia; and from within, or from the borders of, this district have come all the conquering races of the Old World. We have the Tartar race,

which, passing the southern mountain-boundary of this rainless district, peopled China and the regions between it and India—thrusting the aborigines of these areas into the hilly tracts; and which has sent successive waves of invaders not into these regions only, but, from time to time, into the West. We have the Aryan race, overspreading India and making its way westward through Europe. We have the Semitic race, becoming dominant through North Africa, and, spurred on by Mohammedan fanaticism, conquering parts of Europe. That is to say, besides the Egyptian race, which, seeming by its alliances to have originally been of low type, became powerful in the hot and dry valley of the Nile, we have three races, widely unlike in type, and speaking languages classed as fundamentally distinct, which, from different parts of the rainless district, have spread as invaders over regions relatively humid.

Original superiority of type was not the common trait of these races: the Tartar type is inferior, as well as the Egyptian. But the common trait, as proved by subjugation of other races, was energy. And when we see that this common trait, in races otherwise unlike, had for its concomitant their long-continued subjection to these special climatic conditions—when we find further, that from the region characterized by these conditions, the earlier waves of conquering emigrants, losing in moister countries their ancestral energy, were overrun by later waves of the same races, or of other races coming from this region, we get strong reason for inferring a relation between constitutional vigor and the presence of an air which, by its warmth and dryness, facilitates the vital actions.

A striking verification is at hand. On turning to the rain-map, it will be seen that, of the entire New World, the largest of the parts distinguished by the absence of shade as almost rainless, is that Central American and Mexican region in which indigenous civilizations developed; and that the only other rainless district is that which formed part of the ancient Peruvian territory—the part, moreover, in which the pre-Inca civilization has left its most conspicuous traces. Inductively, then, the evidence justifies in a remarkable manner the physiological deduction.

Nor are there wanting minor verifications. Comparisons among African races are suggestive of similar contrasts in constitution, similarly caused. Of the varieties of negroes Livingstone remarks ("Missionary Travels," p. 78): "Heat alone does not produce blackness of skin, but heat with moisture seems to insure the deepest hue;" and Schweinfurth, in his lately-issued "Heart of Africa," similarly remarks on the relative blackness of the Denka and other tribes living on the alluvial plains, and contrasts them with "the less swarthy and more robust races who inhabit the rocky hills of the interior" (vol. i., p. 148). There seem, generally recognizable, corresponding differences in energy and social advance. But I note this difference of color arising

in the same race, between those subject to a moist heat and those subject to a dry heat, for the purpose of suggesting its probable connection with the fact that the lighter-skinned races are habitually the dominant races. We see it to have been so in Egypt. It was so with the races spreading south from central Asia. There is evidence that it was so in Central America and Peru. And if, heat being the same, darkness of skin accompanies humidity of the air, while relative lightness of skin accompanies dryness of the air, then, in this habitual predominance of the lighter-complexioned varieties of men, we find further evidence that constitutional activity, and in so far social development, is favored by a climate conducing to rapid evaporation.

I do not mean that the energy thus resulting determines, of itself, higher social development: this is neither implied deductively nor shown inductively. But greater constitutional activity, making easy the conquest of less active races and the usurpation of their richer and more varied habitats, also makes possible a utilization of such habitats that was not possible to the aborigines.

## THE HYDRAULICS OF GREAT RIVERS.

AN important advance in our knowledge of hydraulics has been recently effected through the observations of M. Révy, a member of the Institute of Civil Engineers of Vienna, on the great rivers of Paraná and Uruguay in South America. The results of his observations have just been published in England, in a book entitled "The Paraná, the Uruguay, and the La Plata Estuaries," an excellent account of which appears in the April number of the *Edinburgh Review*, from which the following statement is derived. Before giving the details and results of M. Révy's observations, it is advisable to furnish a brief description of the character and appearance of the streams observed.

The La Plata is simply an estuary or arm of the sea into which empty the Uruguay and the Paraná. It trends in a northwesterly direction, is 70 miles wide at its mouth, and 150 long to the mouth of the Uruguay. Higher up still it loses itself in the Paraná Guayaza and the Paraná de las Palmas, *embouchures* of the Paraná proper, which branches 72 miles above to form a delta. The Uruguay and the Paraná are the main arteries of the vast basin formed by the Andes on the west, the mountain-chain which runs parallel with the Atlantic Ocean on the east, and on the north by the great range of Cordilleras which stretch directly across the South American Continent at the fifteenth parallel of south latitude. Their water-shed is the southern slope of these Cordilleras, while that of the Amazon

is the northern slope. Of the two rivers, the Paraná is much the larger, being second only to the mighty Amazon in size. It maintains an almost uniform width of three-fourths of a mile to a mile, and a depth of 50 to 70 feet for 852 miles, in a comparatively direct line from its mouth to the confluence of the Paraguay. Above this point it is not navigable except for small vessels, at certain seasons of the year; but the Paraguay, which is undoubtedly entitled to be considered the main stream, is navigable for 1,000 miles farther. The banks of the Paraná Guayaza rise only about two feet above the water, but are of firm soil. They are covered with dense forests of a glossy-leaved tree called *sieba*, somewhat resembling the laurel, and a thick undergrowth of rushes. The scenery retains this general character for 98 miles, where a bluff is sighted on the right or southwest bank of the river. About ten miles higher up, the river rushes with great force through the Straits of Obligado, a pass between two steep bluffs, about half the regular width of the river apart. At this point the stream is 150 feet deep. Excepting at this place, the left bank of the river is formed by an immense, low swamp, from 15 to 30 miles in width, for 253 miles from the mouth, while the right bank, for 100 miles above the straits, is formed by the high table-land of Buenos Ayres. The first cataract of the Paraná occurs about 150 miles above the confluence of the Paraguay, and it is this which renders the upper part of the river unnavigable, except for small vessels, during the floods which annually occur. About 550 miles above this cataract are the Falls of Guaira. These are not perpendicular, as Niagara, but inclined at an angle of about 50° from the horizon, with a fall of 50 feet. Above the falls, the Paraná is 4,500 yards wide, from which it suddenly contracts between granite walls 70 to 80 yards apart. Into this pass the water rushes with such tremendous fury, that clouds of spray arise and fall in perpetual rain over the neighborhood; the roar is such that no other sound can be heard, and the listener is made deaf by the thunder; even the very earth trembles, so that it has become desolate.

The Uruguay, a great river by itself, is almost insignificant in comparison. At the mouth, its channel is broad and deep, but at 200 miles above it dwindles into a torrent six feet deep, flowing through a rocky pass 145 feet wide. It is, however, subject to floods in September and October, during which it rises at the rate of three feet per day to 50 feet above the usual low-water line. At this time, the volume of the river is greatly increased by enlargement of the waterways, and a more than tenfold increase in the velocity of the current, which, at ordinary times, is about five miles per hour in the pass described.

The Paraná, on the other hand, although, as we have already seen, similarly subject to an annual overflow, displays nothing like the violent fluctuations of supply belonging to the Uruguay. M. Révy tells us that the ordinary annual rise at Rosario, 189 miles from the mouth

of the Paraná Guayaza, where the river is about three-fourths of a mile wide, is 12 feet, and that the flood-level is always maintained for three months. The river occasionally rises to 24 feet above the low-water line, but this is rare, and its low-water supply never falls below half the volume of the ordinary flood. At a point near Rosario, where the river is 4,787 feet wide, a series of measurements has been made by M. Révy, which constitutes the largest measurement of a river section yet effected. "The depth increases by a gentle and regular slope, from that of a few inches, on the left shore, to 72 feet, at a distance of about 1,100 feet from the right bank. Thence it rapidly shallows to about 12 feet, and then rises gradually to the foot of a vertical cliff, forming the right-hand shore of the river." These measurements were made in January, when the river was at low water. The average depth was 47½ feet, and the greatest 72 feet, while the sectional area measured 184,858 feet. The same section, during the ordinary flood, gives a measurement of 243,000 feet, or a little less than one-third greater. This, however, does not give an adequate idea of the increase in volume, as, at the height of the flood, the left bank of the river is submerged for many miles. The flow, independent of the escape over the marshes, is estimated, according to M. Révy's data, as 40,000,000 metric tons per hour at low water, 83,000,000 at the ordinary flood, and 169,000,000 at the occasional extraordinary floods.

The velocity of a river depends upon the inclination or fall of its course, and its surface velocity can be ascertained by determining the rate of that fall per mile, and *vice versâ* we can ascertain the inclination by measurement of the surface velocity. But, as every one who has stirred up the bottom of a brook has observed, the surface-current flows faster than the under-current. The particles of sand at the top of the water are always carried some distance beyond those at the bottom. This retardation of the under-current is caused by the friction of the water against the bottom and sides of the brook. While therefore, it is easy to measure the velocity of the surface-current, it is difficult, because of this retardation beneath, to determine the mean velocity or actual flow of the river. This has never been satisfactorily done before. Many experiments, with a view to the accomplishment of this end, have indeed been made by eminent men, but they have failed to establish the relationship between the depth of the stream and the velocity of the flow. M. Révy has established that the velocity of a river is directly proportionate to its depth, diminishing or increasing therewith. "Thus if a shoal occurs in the middle of a channel, the velocity of the current over the shoal is less than that of the deeper water on either side; and this diminution of speed is proportionate to the loss of depth. So direct is this relation, that a plan of the surface velocities, if projected on an appropriate scale, coincides very closely with the section of the bottom of the river. Any want of parallelism between the two curves is capable of expla-

nation either by the curvature of the banks, or by some physical irregularity of the channel." It was determined by actual experiment that the greatest velocity of current is at the surface and the least at the bottom, and that the increase of velocity "is in the simple ratio of the distance from the bottom." This decides that the mean velocity of a stream is to be found at half its depth. A result perfectly consistent with the previously expressed law that surface velocity is proportionate to depth, it is in fact a corollary, and one that was verified by experiment.

For determining the velocity of a stream, M. Révy employed an instrument called the current-metre. This consisted of a propeller-like wheel attached to a long axle and made to turn with rapidity when immersed in a running stream. The wheel is fastened to a kind of rudder which keeps it always against the stream. The upper end of the axle moves a set of cogs which turn a couple of indices upon a dial-plate. M. Révy is not the inventor of the instrument, but he improved it so as to greatly increase its utility. He first ascertained the correct reading of the metre by moving it through still water, and next made an extensible addition to the axle, so that the instrument could be adjusted to any depth.

An interesting verification of M. Révy's discoveries with regard to the velocity of currents was unexpectedly made. "In two successive measurements of the current of the La Plata, he found that there was a decrease of surface velocity and an accompanying increase of lower velocity. This at first seemed to contradict his previously-obtained results, but on further examination it was discovered that the depth at those points was sixteen inches greater. The water was banked up by its own mass so that the surface fall was less than at the point of previous measurements. "In obedience to known hydraulic law, this decreased surface-inclination was indicated by decreased velocity of surface-current. But the power of the whole moving mass was greater in proportion to its depth. And thus, while to the superficial gaze the velocity was less, the mean velocity was greater; and the river swept with more resistless energy over its bed. This luminous observation is the opening of an entirely new chapter in hydraulic science. It is, in fact, a case of the law of relation of speed to depth; but it is one that could scarcely have been arrived at by theory; although, now that it is experimentally ascertained, its theoretic reason is ascertainable."

These results, of course, require further verification elsewhere, but they cannot fail to be of the highest value both to experimental and practical science, for they will at any rate furnish method, and give new impetus to hydraulic investigation. Should they be verified, and they probably will be, it will follow that wherever water-power is desired, as in mill-races, or abundance of water-supply, as in aqueducts, depth of way should be secured at the expense of breadth.

And again, they will render valuable aid to the science of meteorology. We have as yet no knowledge of the constants of evaporation from water-surfaces. On this point the Edinburgh Reviewer remarks: "An unusually favorable opportunity now presents itself for the actual determination of the most steady and remarkable case of evaporation that occurs on the surface of our planet. In its headlong course from the foot of Hermon, the Jordan (well named *the descender*) may almost be said to consist of three continuous cataracts, divided by two lakes and terminating in a third. From the surface of that bituminous sea, the whole supply brought down by the Jordan and its affluents is exhaled in invisible vapor. By an accurate measurement of the volume discharged by the Jordan, we shall be furnished with evaporative data of the highest value."

## ANIMALS EXTINCT IN THE HISTORIC PERIOD.

BY EMILE BLANCHARD.

TRANSLATED FROM THE REVUE DES DEUX MONDES, BY A. R. MACDONOUGH.

ALL beings are exposed to more or less frequent dangers, and are constantly struggling to defend their lives. They have to dread the inclemency of the seasons, and must perish if they fail to find a sufficiency of food; the herbivorous are destined to become a prey to the carnivorous, and, when there seems no need of a victim, deadly battles occur for the possession of a place or the conquest of a prize. Destruction is a natural law; but this destruction is restrained within certain limits: notwithstanding the perils that incessantly threaten the existence of all creatures, every thing works actively to secure the maintenance of races. That instinct of preservation which goads individuals to fly from danger and seek the satisfaction of their material wants, allows many to escape accidents. If the causes of violent death vary within the widest range among animal species, they are always proportioned to the causes that protect against it. Fecundity, restricted among powerful animals, and limited also in those that have only the attacks of the strongest to fear, is prodigious among the weakest that are doomed to yield a multitude of victims. Thus the complete disappearance of any species is only possible under wholly exceptional conditions. Usually, the species destroyed at one point continues to propagate itself at another: if abundant at one period, it is rare at another, when circumstances become unfavorable; yet it has not ceased to be represented, in some corner of the world. Certainty in this respect has been gained by exact and very numerous observations. Since the day when the last grand physical phenomena were

completed on the surface of the globe, few animals have disappeared. Only some great species have become extinct, and man alone is the author of that extinction, so much to be regretted. It has been supposed that species, like individuals, were doomed to perish. It might be difficult to form any other conclusion, were we to consider the relics of those beings that have lived in the different geological periods; but if we examine the world as it exists we are forced to reject that belief, except on the supposition that new disturbances will hereafter occur on our globe.

I.

While Central Europe, almost completely given up to Nature, was covered with vast forests and its inhabitants were thinly scattered, animals found few obstacles to their increase. The great species, quite rare in our time, were common in very many localities. Wild-oxen, aurochs, moose, and stags, roved in great herds, having nothing to fear but carnivora, especially bears and wolves. Men increasing in numbers changed the condition of the region; the animals were driven closer, and several of the more remarkable species, being easy to reach and attack, soon disappeared. The blind cupidity and love of destruction that possess uncivilized races have caused the loss of animals that might have been useful and valuable to man.

In spite of all this, the number of mammals entirely destroyed since the last important changes that have occurred in the climates of Europe is inconsiderable. It is now proved that man was already in existence during the epoch in which elephants clothed with a thick fleece, the rhinoceros, the cave bear and hyena, lived in our countries, and the reindeer was scattered over the land in abundance. Thousands of bones, collected side by side with wrought articles, have given incontestable proofs of this; but the disappearance of elephants and that of several other species must be attributed chiefly to natural causes, and with those we have no concern at present, even when speaking of a partial destruction. In fact, various animals, extinct in some parts of the world, under the influence of atmospheric conditions, have maintained an existence in regions subjected to a climate adapted to them. The reindeer, which was distributed through an immense geographical range in the glacial period, is the most striking instance of this.

A very large mammal, whose existence is not preserved by any tradition, must nevertheless have been among those exterminated by man; that is, the great-horned stag, also called the Irish fossil elk, an animal of the size of the ordinary elk, with the general form of the stag, and enormous horns attaining a spread of more than nine feet. Relics of this magnificent elk have been found in the boggy lands of France, England, Italy, Germany, and Poland. But the remains of this superb animal are chiefly found in Ireland, under those peat-beds which, in all probability, were formed at no very remote period.

Judging from that circumstance, naturalists are inclined to think that the great-horned elk must have long survived the extinction of the great pachyderms. Of late years bones of this species have been found in such quantities as to allow the construction of entire skeletons.

If the existence of the Irish elk is too much a thing of the past to have received historic mention, the case is otherwise with the great wild-ox of Europe (*Bos primigenius* of naturalists), an animal whose size surpassed by a third that of our domestic oxen. This ruminant has left abundant remains in the bottoms of water-courses, in alluvials, peat-bogs, and caves. Like the bison which still survives, it inhabited the forests of Central Europe less than 1,000 years ago. The fact is proved by the writings of old authors. Cæsar was not acquainted with the bison, but he describes with vivid touches the wild-oxen of the Hercynian forest, which he calls by the name of the urus. "They have," says the Roman conqueror, "a stature little below that of elephants; in appearance, color, and form, they are like bulls. Of great swiftness and extremely powerful, they spare neither men nor beasts when seen. They are taken in trenches skillfully prepared. The youths fit themselves to endure fatigue by the practice of hunting these animals. Those who kill many of them display their horns publicly in proof, and receive great applause. The urus can neither be tamed nor accustomed to the sight of man, even though taken very young. The horns of these animals differ much from those of our oxen, in size, shape, and appearance. They are much sought after by the natives, who decorate the edges with a silver circlet, and use them for goblets at great feasts."

The two bovine species of ancient Europe are plainly designated in Seneca's verses: wild-oxen, with great horns, and bisons, with shaggy backs. Pliny makes the same distinction between the wild-oxen of Germany, bisons having a mane, and the urus remarkable for strength and swiftness, to which the name of *bubalus* is commonly wrongly given. That name really belongs to the buffalo (*Bos bubalus*), an animal native to Asia, and long ago well known to the Greeks; but it is generally used in the middle ages to denote the *urus* of Cæsar. The species had not disappeared from the forests of the Vosges and Ardennes during the first centuries of the French monarchy, for Gregory of Tours relates that, by order of King Gontran, a chamberlain, his nephew, and a forest-keeper, were put to death, for having killed a "bubal" in a royal forest situated in the Vosges. Besides, Venuntius Fortunatus, the poet, bishop of Poitiers in 599, mentions in his verses the bubal among the animals hunted in Ardennes and the Vosges by Gogoor, the first mayor of the palace of Austrasia, mentioned in history. The existence together in the Central European forests of the two ruminants mentioned by Latin authors is once more attested by a passage in the famous poem of the "Nibelungen." It is the description of a magnificent hunt; the Burgunds dwell on the banks of the

Rhine, and their king, Gunther, leads Siegfried the Strong, the hero of the poem, into the forest of Odenwald, where dwell bears, elks, wild-boars, stags, and oxen. Siegfried distinguishes himself among all his comrades by killing a great number of wild beasts, and among others a bison and four urus. According to Eckhart, the learned Benedictine, the great ox or bubal was still existing in the Hyrcanian forest in Charlemagne's time, and certainly in some parts of Helvetia. A proof of the latter point is given by the catalogue of meats in use among the good monks of Saint-Gall; the urus, or bubal, and the bison both appear on the list.

Thus it is impossible to doubt that two wild bovine species were living in Europe till the eleventh century; but, dating from that epoch, nothing more is said of the great-horned ox, the urus of Cæsar, the bubal of common people. The utter silence of all writers shows that the destruction of the species was complete. One of the finest animals in the world had become extinct.

Very soon after naturalists had begun to search for the remains of animals belonging to ancient geological periods, they dug up bones of a huge ox, with remains of the core of horns of surprising size. Whole heads and different parts of skeletons were found in rivers, marshes, peat-bogs, in the north and east of France, in England, Germany, and Italy. After careful examination, Cuvier did not hesitate to recognize in these bones the relics of the urus of the ancients; the fact was put beyond doubt by comparison of texts, and studies of the characteristics known to osteology. But that illustrious zoologist, in regarding as the primitive stock of our domestic species that great wild-ox described by Cæsar and hunted by Charlemagne's contemporaries, fell into an error that is now fully admitted. Our oxen came from Asia; in spite of conditions very favorable to bodily development, they retain a size far less than that of the wild species, and are distinguished from them by several marks, particularly by the curve of the horns. Multiplying freely for three centuries in the pampas of South America, they show no tendency to take the dimensions or other characteristics of the urus, which, moreover, was never subdued to the yoke by man.

At a later date than that of Cuvier's writings, a professor of Wilna, Bojardus, obtained an almost perfect skeleton of the great ox of the ancient Gallic and German forests, and, supposing the species to be fossil, he gave it the name, which is now generally used, of *Bos primigenius*. Of very late years, fortunate discoveries encouraged the hope of success in reconstructing the history of humanity previous to historic times, with the aid of materials obtained by excavation. Researches carried on with extreme ardor have collected a vast number of objects that throw an entirely new light on the life of men and animals in the epoch called prehistoric. Remains of the *Bos primigenius* have been discovered in great quantities in grottoes, sandy deposits, and alluvial soil; and some have been obtained from the lake

habitations of Lake Constance, where they have been made into utensils. By this means every thing relating to the great-horned wild-ox has become thoroughly known. The *Bos primigenius* is no other than the urus of Cæsar, Seneca, and Pliny, the *bubalus* of Fortunatus and Gregory of Tours, a species contemporaneous with the great pachyderms and great carnivora extinct long before historic times, but which continued to live amid the forests of Central Europe until completely exterminated by men, only eight or ten centuries ago.

The bison of the ancients, now called the aurochs, is not entirely destroyed, though its early complete disappearance is threatened. It yet lives in the condition of a zoological specimen, and there have been opportunities of late of seeing it in some menageries. Formerly it was spread over the greater part of Europe, but it has only been found in certain regions since the historic period began. Aristotle mentions it under the name of *bonasus*, as an animal of Pœonia, that is, of the part of Thrace which is now Bulgaria, and gives a tolerably exact description of it. That which particularly strikes the Greek author in the bonasus is its body, larger than that of the common ox, the mane covering its nape to the shoulders and falling over its eyes, and the woolly hair, of a reddish gray on the lower parts; marks which agree only with those of the bison. Oppian and Pausanias, as well as Seneca and Pliny, speak of the bison, so easily recognized by his heavy neck and shoulders, rounded forehead, shaggy back, and long legs. It was supposed that the aurochs had already disappeared from Gaul at the time of the Roman invasion, because Cæsar makes no mention of it. The proof is imperfect, and it cannot be doubted that the bison was still existing, several centuries later, together with the great wild-ox, at least in Ardennes and the Vosges. It seems to have maintained itself much later in the great Hercynian forest, which stretched from the Rhine to the Danube; but, since a date that cannot be exactly fixed, it has ceased to inhabit the eastern parts of Europe. In our time there remain only a few pairs in Lithuania, in the forest of Bialovicza and in the Caucasus. In the latter country it would appear that the aurochs is now quite rare, for Prof. Brandt, of St. Petersburg, the *savant* who has given most study to the mammals of Russia, had fears that the disappearance of this fine animal was complete; but he learned that they were still to be met with in a locality called Rudeln. More recently we have been informed that a small herd of some fifty animals was known to exist near the village of Atzikhar, on the upper Ouroup. Not a solitary one would remain either in Lithuania or the Caucasus, did not the Russian law forbid taking or killing an aurochs without imperial permission, under pain of death.

The elk, the stag, the chamois, and the wild-goat, still belong to the European fauna; but, unless measures are taken to check the destruction of these mammals, very few centuries will pass before their complete extermination.

Every one who visits a museum of natural history experiences surprise at sight of the moose, a kind of enormous deer. A clumsy form, long legs, a thick muzzle, an extremely short neck, a tuft on the withers, a dewlap fringed with hair under the throat, give the animal an extraordinary appearance, which, in the male, is heightened by huge horns, flattened and serrated on the outer edge. The moose inhabits the marshy forests of the northern parts of Europe and America; it is affirmed that it may still be found at some points in eastern Germany, and it is chiefly met with in Sweden and Norway, Lithuania, the north of Russia, Siberia, and Tartary. It was formerly spread over all Germany, as the hunts of the middle ages preserved in narratives prove. For the authors of the seventeenth or eighteenth century the moose continues a tolerably common species in Poland and Sweden, but is rare for the moderns. Though become quite uncommon in Europe within a hundred years, it continued very abundant at the same period in the Northern United States of America; but every winter it is more eagerly pursued, and this fine animal has ceased to be reckoned among the resources of food for the inhabitants.

In early days our European deer roved everywhere in herds under the great forests, and now scarcely any of them exist in France, except in particularly well-protected forests, where they may be counted by single specimens. Every one has heard retired hunters say again and again, in speaking of deer, "Very soon there will be no more of them." The smaller ruminants, that delight in the cliffs of the highest mountains, and the neighborhood of glaciers, are spared as little. The destruction of the chamois and wild-goat is going on with lamentable rapidity, and it is completed with no other object than the desire of exhibiting skill. The mountaineer is proud of having killed a chamois, and if he kills several he thinks himself a personage deserving admiration. Go to Switzerland, and they will show you, in a hundred places, some part of the mountains where herds of chamois were formerly seen, and you will hear it almost uniformly declared that now there are very few of them, or none at all, left. Go to the Pyrenees; in that region, where the chamois is called the isar, they will tell you that the isar is now exceedingly rare. The chamois, the single European representative of the antelope group, being found scattered over all the great mountains of Europe, will doubtless long maintain itself against the unceasing pursuit of hunters; but the pretty wild-goat of the Alps, once very widely spread, no longer exists, except in a very confined part of the Piedmontese Alps, and perhaps in some nook of Mont Blanc. The chamois and goat, agile animals frequenting most inaccessible regions, swift to fly at the approach of danger, often escaped the hunter's aim when the weapon carried no great distance; long-range guns have become the scourge of Alpine animals.

Thus, within historic times, the *Bos primigenius*, the huge, great-

horned ox of Gaul and Germany, has been exterminated. The bison, the largest of mammals in modern Europe, is on the point of disappearing. The other wild ruminants are threatened with more or less remote extinction, and the local authorities in each country hardly understand the importance of checking a deplorable mischief which will soon be beyond remedy.

The history of the beaver is too well known to be repeated at length. A mammal of the highest interest from its habits, valuable for the products it yielded to commerce and manufactures, the beaver, the largest of our rodents, was abundant in France and a great part of Europe, down to the middle ages. In our day, its existence is almost questionable. For several centuries they have been seen only on the banks of the Rhone, or some affluent of that great river, and the few individuals observed in their solitude, far from being objects of special protection, have always been killed. It seems that quite lately a little family of beavers was discovered on an island of the Rhone; it was a piece of good luck, bringing the hope of seeing a nearly extinct species revive again in the country. They were all destroyed without mercy; such a piece of stupidity is possible among civilized people, when those who commit it do not even understand the wrong they are doing. At present beavers are hardly more common in the other parts of Europe than they are in France, and everywhere their buried bones, in mud and peat-bogs, remain the witness of those associations which were the wonder of animal life. In Canada, beavers almost identical with those of Europe were still quite generally found at no very remote time; but they have become extremely rare. Their destruction has been brought about very rapidly, through the cupidity of those great companies formed in North America in the last century for trading in furs.

Extermination, pursued in a senseless fashion, has not only fallen upon land mammals, but has been carried on as to marine species with even greater fury. The large animals of the sea gave rise to active industry and important commerce; but selfishness, and the love of gain, which forget the future in the present, have dried up that source. A century ago, the whale was the object of most profitable fisheries, and those huge cetacea are now so uncommon that their pursuit is given up by most of the nations that once grew rich by following it. Whalers were not content with the capture of old fish, but took younger ones, of very little value, as well as those full-grown. The satisfaction felt in depriving others of the possibility of a good catch two or three years later was too great to permit the reflection that success would thus soon become impossible for all whalers.

The *rytina*, an herbivorous, cetaceous animal, belonging to the lamantin and dugong group, called sea-cows by the inhabitants of the coasts, was common a few hundred years ago in the latitudes of Behring's Islands. This animal, which attained a length of about

sixteen feet, was valuable as a resource for the northern tribes, especially the Esquimaux; the flesh provided very acceptable food, and the skin was of use in making their canoes. The pursuit of the rytina has been followed unceasingly, without the least restraint, and these useful cetacea entirely destroyed; the last living one was taken in 1768.

The rytina, covered with a bare skin, black in color, and wrinkled like the bark of an oak, had a mustache with hairs as thick as the quill of a pigeon's feather. These harmless animals delighted in herding together, young and old mingled, and a male and female were often seen moving about together, accompanied by their young family. The rytina usually haunted rather shallow, sandy places, particularly near rivers. They fed on various marine plants, showing a preference, however, for a particular kind of sea-weed. The animals were often seen browsing as they swam slowly, or walked along the bottom, stepping leisurely, like cattle in the fields, and, when satisfied, coming to the shore to lie on their backs. Sometimes in the winter they would be caught and confined under the ice, and die for want of air, their bodies afterward washing ashore. This explains the ease with which, even now, great quantities of the bones of these herbivorous cetacea of Behring's Islands are collected. All that we know of this animal's history has been handed down to us by the memoir of a naturalist and physician, Steller, published in 1751. He accompanied Behring on his voyage to the northwest of America. After the wreck of the ship, followed by the death of the commander and the greater part of his crew, Steller remained on the islands, to which he gave the name of the Russian navigator, till the sailors escaped from the wreck had built a vessel out of the fragments of the ship, which gave them the means of reaching Kamtchatka. Very lately, Russian zoologists have made all possible efforts to rediscover Steller's rytina, but all the labor of their researches has been fruitless. They have only succeeded in procuring some of the animal's bones, and in 1861 the *savants* of St. Petersburg, Moscow, and Helsingfors, had the satisfaction of receiving almost entire skeletons, sent to the governor of the Russian-American possessions, which gave an opportunity for important studies on the osteology of this singular cetacean by Brandt and Nordmann.

II.

The losses suffered by birds have been different, and far more serious than those of mammals; various species, highly remarkable either for great size, or for almost exceptional peculiarities in conformation, have completely disappeared. As to some, the fact is certain, and the presumption is strong as to others. Incapable of flight, and confined to islands, these birds could not escape the attacks of men, and men have exterminated them.

When Pedro de Mascarenhas discovered the islands of the Indian Ocean, in the early years of the sixteenth century, Mauritius, Rodriguez, Bourbon, formerly St. Appolonia, and now Reunion Island, which were called, after the name of the Portuguese navigator, the Mascarene Islands, these regions, covered with rich vegetation, were inhabited by birds in great numbers. Besides species belonging to groups represented in other parts of the world, as parrots, sparrows, pigeons, ducks, there were living some species which excited the astonishment of the navigators by their really extraordinary appearance. There were the *dronte*, or dodo, and the hermit-bird, which have furnished modern authors the theme for numberless writings. Naturalists long cherished the hope of finding again, at some point of the globe, those strange creatures which had no near relationship with any other living being; but the most zealous research has been fruitless, and the hope is abandoned. Many efforts have been made, with the aid of some remains, and a few imperfect sketches, to reconstruct those strange, extinct birds in a scientific way, without any early satisfactory results. Lately, the bones of these vanished species, gathered in tolerably large quantities, either at Rodriguez, or from a marsh in Mauritius, have enabled us to gain clearer ideas of them.

The dodo exceeded the swan in size, and presented the most extraordinary appearance. It had a massive body, supported on thick, short legs, like pillars, a swollen neck, a round head set off by a fringe of feathers brought forward over the face like a hood, great black eyes, ringed with white, and a huge bill, of which the two mandibles, rounded and broad at the end, and terminating in a point in the other direction, have been compared to two spoons laid with the hollow of the bowls against each other. The dodo had wings; but these wings, quite small, mere elements of wings, could be used for nothing; it had a tail, but the tail was reduced to a sort of tuft, made of four or five curly feathers. Then it had silky plumage of a gray color, lighter on the lower parts than on the back, and shaded with yellow on the wings and tail. The animal, absolutely ugly, clumsy, and stupid in its look, inspired repugnance. Buffon, who spoke of it as we do, from sketches and descriptions given by ancient observers, says, that it would be taken for a turtle muffled in a bird's skin.

The earliest notices of the natural productions of Mauritius Island come to us from a voyage made by the Dutch, in 1598. Cornelius Van Neck, the leader of the expedition, finding the island uninhabited, took possession of it, and traveled through the country with his companions, and in the account of his voyage he notes the most remarkable animals and vegetables that were met with on the island. He speaks of the dodo, described as a *Walgvogel*, "a disgusting bird." The animal, represented by a rather coarsely-executed picture, is described in simple terms, of which this passage will give some idea. "It is a bird," the narrator says, "which we called the disgusting

bird, the size of a swan, has a round tail, covered with two or three curly tufts, has no wings, but instead of them there are three or four black tufts: of these birds we caught a certain number. . . . We cooked the bird; it was so leathery that we could not boil it enough, but we ate it half raw."

In 1601 two Dutch squadrons, one commanded by Hovmansz, the other by Van Heemskerk, sailed together from the East Indies on their return to Europe. The vessels soon parted, those of Heemskerk anchored at the island of Mauritius, and this time the crews found the dodo remarkably good eating. They probably understood better than Van Neck's men how to prepare them, and those they killed were perhaps fatter or younger. They ate a great number, and salted others down for the remainder of their voyage. Other birds abounded in the island, but were less easily caught than the great dodos, which had no power to fly, and no other means of defense than their huge bills. In the years following, Dutch navigators often landed at the Mauritius, and the dodos, killed with clubs by the sailors, always furnished a large part of the crews' provision; they worked zealously for the destruction of the poor birds, unable to escape pursuit. The Englishman, Sir Thomas Herbert, visiting the island in 1627, found the dodo still there; and Francis Cauche, a French sailor, author of the narrative of a voyage to Madagascar, touching at Mauritius in 1638, also saw there the dodo, or, as he called it, the nazar-bird, which builds its nest from a heap of grasses, on the ground. About the same date, a living dodo was exhibited in London: fortunately, artists took the opportunity to draw from nature the likeness of this strange bird, and the Dutch painter, Roelandt Savery, in particular, depicted it under various aspects. In this way the general appearance of this extinct species has been preserved for us. After the death of the one brought alive to England, it was stuffed, and at last found a place in the museum founded at Oxford by Ashmole.

Up to 1644 Mauritius Island, pretty frequently visited by navigators, had remained unpeopled; but in that year the Dutch founded a colony in it. Such an establishment of course brought about the extinction of the dodo, in which the dogs, cats, and pigs, introduced into the country, no doubt did their part by eating the young and the eggs. The last evidence of the dodo's existence dates in 1681; it is given by the log of an English sailor named Harry, aboard a vessel that wintered at Mauritius, homeward bound from India. In this document, preserved among the manuscripts of the British Museum, the dodo is mentioned as having very tough flesh. And here the first part of the strange creature's history ends.

In 1693 the French naturalist Leguat pursued for several months an exploration of Mauritius Island. He describes a number of animals seen in the country, but he neither met with the dodo, nor did any one speak of it to him. The bird was extinct, and all attempts to

find it vain; far less than a century had sufficed for the destruction of a species once abundant at one point on the globe.

At the period the dodo lived in, the natural sciences were very little advanced, and the animal was not the subject of any serious study. Long afterward, zoologists continuing to be struck with the unusual interest attaching to this extinct bird, which was quite unique in creation, felt a laudable desire to complete the imperfections left by ancient accounts of it; but the materials remaining to throw light on the subject were very scanty. The stuffed specimen that had figured in the Oxford Museum had been sacrificed in 1755. The vice-chancellor of the university, and the other commissioners charged by Ashmole with the care of preserving the treasures he had collected, came at an unfortunate hour, as the excellent Strickland says, on their yearly visit to the museum. The poor specimen, more than a century old and doubtless much dilapidated, yet invaluable as the last of the dodos, was committed to the flames by order of the intelligent managers. By good luck, again, they preserved the head and one foot of the animal; scientific interest had nothing to do with the rescue; it was what the world calls an act of good administration.

When modern zoologists undertook to examine the characteristics and natural affinities of the dodo, the relics saved consisted only of the head and foot existing in the Oxford Museum, a foot in the collection of the British Museum at London, a head at Copenhagen forgotten for two hundred years and found again by chance, and a beak at Prague, more recently recovered.

These wretched remnants and the sketches already mentioned, when examined and compared from different points of view, opened a field for dissensions. A single fact was patent to all eyes, the very peculiar, very abnormal character of the dodo. Naturalists, as is usually the case, at first struck by peculiarities of a secondary order, marks of adaptation to a special kind of life, gave their most particular attention to the rudimentary state of the wings in the bird of Mauritius Island. A similar condition of the organs of flight existing in ostriches, and cassowaries, the idea of a more or less close relation between the dodo and those birds suggested itself. Dwelling on a consideration of the same kind, a resemblance was found to penguins and auks, with no greater reasonableness. Prof. de Blainville, paying more regard to the shape of the bill than any thing else, saw in the dodo a representative of the vulture group. Yet a bird of prey incapable of flight, unable to pursue its victims, might seem to us a very extraordinary creature; it must be supposed in such a case that snails, insects, and worms, were the animal's usual food, the resource of dead bodies having scarcely any existence in a region without mammals, like the Mascarene Islands. It has been supposed that the dodo had affinities with the gallinaceous tribes, that is with cocks, Guinea-fowl, turkeys, and some stilt-birds, and that it represented an

intermediate type between different families in the class of birds; in a word every supposition was adopted without approaching the truth, so long as the examination was insufficient. Reinhardt, after carefully examining the dodo's skull preserved in the Copenhagen Museum, thought he discovered characteristics pointing out a zoological relation beteen the bird of Mauritius and pigeons. A few years later, a great step toward a solution was made. Strickland, availing himself to the utmost of all procurable materials, published in 1848 an important work on the dodo. The fragments we have noted as existing in the Oxford Museum, a head and a foot, had been stripped of integuments, so as to allow the study of the bony parts; a singular pigeon, the *didunculus*, having a large curved bill, slightly-developed wings, and feet well formed for walking, had been discovered in the Samoa Island by an American *savant*. This pigeon, recalling slightly the marks and habits of the dodo, notwithstanding its small size, furnished a new and most valuable term of comparison. Strickland succeeded in this way in proving that the dodo approached very remarkably the family of Columbids, that is, of pigeons.

After the researches of that able naturalist, no more light could be expected with regard to the famous bird formerly hunted out of existence by the Dutch sailors, without some important discovery. Such a one has quite lately been made in Mauritius Island. In draining a small marsh, poetically called Dream Swamp, George Clark discovered a quantity of dodos' bones. These remains, sent to England and very soon distributed throughout France, quickly attracted attentive study; they permitted the almost complete reconstruction of the skeleton, and in the present state of science all imaginable means of comparison were at hand. Several zoologists gladly profited by these advantages. Alphonse Milne-Edwards, thoroughly familiar with the osteological characteristics of birds, entered actively on the investigation, and we think has succeeded in determining precisely the natural affinities of this singular bird. Recognizing, with Strickland, the very close relations connecting the dodo with pigeons, Edwards concludes that the bird of Mauritius is the type of a special family. Thus the fragments of the history of this strangely annihilated being have been successively brought together, but the complete account of the species remains beyond the possibility of discovery.

Till the seventeenth century the Mascarene Islands were inhabited by many other birds of which the memory has been handed down to us by the merely superficial accounts of some travelers. These birds, some perfectly unfit for flight, others tolerably well endowed as regards the power of their locomotive organs, but having nothing to fear in the absence of men, lived undisturbed in the unpeopled regions of Rodriguez, Bourbon, and Mauritius. They have been destroyed by the attacks of settlers in a very short lapse of time; and now their bones, still collected in small quantities, are the only vestiges that

denote the places shared in possession with other harmless beings. Travelers in old times have spoken of the hermit-bird of Rodriguez, the red hen with a snipe's bill, the giant, the bluebird of Bourbon, the hazel-fowl, and immense water-hens. The destruction of these animals is utter.

Francis Leguat, flying from France with a Protestant party, came in 1691 to the island of Rodriguez, till then unexplored, and lived there two years. The story of our compatriot's "Travels and Adventures" has been published; we find in it the description of the fine bird called by him the hermit (*Pezophaps solitarius*). Of all the birds in Rodriguez Island, Leguat says this is the most remarkable species. The males are variously feathered with gray and brown, with the feet of a turkey, and the bill shaped like the turkey's also, but a little more hooked. They are almost tailless, and their rump is rounded and covered with feathers, higher on the legs than the turkey; they have a straight and rather long neck, a black sparkling eye, and a head without crest or tuft. The female, our traveler says, is admirably beautiful; there are blonds and brunettes among them, marked on the forehead with a stripe like a widow's band, and on the breast with plumage whiter than the rest of the body. They walk with such a mingling of pride and gracefulness that one cannot avoid admiring and loving them, so that their good looks often save their lives. Not a feather lies uneven on their whole body, such pains do they take to smooth and arrange their plumage with their bills. These hermit-birds do not fly; they only use their wings, which are too small to bear the weight of the body, either in fighting or drumming when calling each other. Leguat adds that they are taken with great difficulty in the woods; but in open places it is easy to run them down, as they are not very swift. From March to September they are extremely fat, and the taste, especially of the young ones, excellent. Some among the males are found weighing forty-five pounds. These birds, intending to build a nest, choose a clear spot, collect a few palm-leaves, and raise the structure a foot and a half above the surface; they hatch but one egg at a time, and the male and female sit alternately during seven weeks, the period of incubation, and for some months longer the young bird needs assistance from the old ones. These beautiful birds of Rodriguez, called hermits because they seldom go in flocks, were abundant in the island at the end of the seventeenth century, when the French naturalist expressed such admiration for them. In a few years they have all perished, and nothing but bones crusted with stalagmite permitted us to ascertain that the species described by Leguat was of a kind unknown elsewhere, when an English explorer, Newton, undertook to examine the caves and boggy lands of the small island of Rodriguez. More than two thousand fragments, the last traces of the extinct bird, were collected. The study of these wretched relics was made with the greatest care, and we now

know that the hermit-bird represented a special type, having close affinities with the dodo and the pigeon. A singular detail leads us to place full reliance on Leguat's observations. Our traveler had said, in speaking of the males of this Rodriguez bird: "The wing of the pinion thickens at its end, and forms a little round mass like a musket-ball under the feathers; this, with the bill, is the bird's chief defense." This little round mass has been found in the shape of a bony prominence on that part of the limb called the metacarpus.

At the Isle of Bourbon, as at Mauritius and Rodriguez, the first explorers found many birds that were clumsy and unable to fly. A species resembling the dodo, described by Dubois, as also by the Dutch Bontrekoe and the Englishman Castleton, was completely white, like a young lamb. A sketch of this bird has lately been found in an old picture; it is a true white dodo, with a yellow tinge on the wings. A hermit observed by the traveler Carré in 1688, probably quite distinct from the Rodriguez species, was magnificent: "The beauty of its plumage," the account says, "is lovely to behold, being a changeable color verging to yellow." A large bluebird with red beak and feet was in all probability of the group of superb sultan-fowls which zoologists call the porphyrions and notornis. All these birds have completely disappeared.

Several species, now extinct, inhabited Mauritius in particular, as the dodo, less than a century and a half ago. Francis Cauche, as also a Protestant missionary named Hoffman, described "red fowls with snipes' bills" which were taken by hand on offering them a bit of red cloth. It would be hard to determine the species by so vague an indication, but a piece of good fortune lately came to our aid. Some paintings on vellum have been discovered in the private library founded by the Austrian Emperor Francis I.; one represents the dodo, another the snipe-beaked hen. De Frauenfeld has published these drawings, and, greatly struck by the extraordinary peculiarities of the red fowl without wings, he has named for it a genus, *Aphanapteryx*, without, however, succeeding in deciding upon the bird's natural affinities. More fortunate, Milne-Edwards had seen some of the bones taken from the famous Dream Swamp, and he clearly recognized in the *Aphanapteryx* a type of the rail family. With this family, and particularly with the group of the swift-runners, well represented in Australia, the same zoologist, after examining some relics, successfully connected the plump waders, covered with light-gray feathers, which Leguat delighted in during his residence at Rodriguez. The same exact historian of the Mascarene Islands, as they once were, has also drawn the description of a very remarkable bird that haunted the marshes of Mauritius. "Numbers of certain birds are seen," says this traveller, "which they call giants, because their head rises six feet high. They are extremely high on the legs, and have a very long body, no larger than that of a goose. They are entirely white except

one slightly red spot under the wing; they have the bill of a goose, but little more pointed, and their toes are very long and somewhat separated. They feed in marshy places, where dogs often surprise them, because they take some time to lift themselves from the ground. We saw one one day at Rodriguez, of such a size that we caught him by hand; this is the only one we observed there, which leads me to think he must have been driven thither by the wind, not being able to resist its force. The bird is tolerably good eating." Much unsuccessful conjecture as to what this "giant" might be was wasted, but at length the able Dutch naturalist Schlegel proved that the species was a kind of water-hen, quite peculiar in character, and in naming it (*Leguatia gigantea*) he meant to perpetuate the memory of the Protestant fugitive whose misfortune became a gain to science.

Nor is this yet all: the bones of a coot much larger than the European one have been found at Mauritius, as well as remains belonging to a parrot, contemporary with the dodo, of the size of a cockatoo; a fragment of another parrot, now extinct, has been found at Rodriguez. We are filled with astonishment in reflecting on what must formerly have been the richness of Nature in the Mascarene Islands; magnificent or wonderful birds were the embellishments of those regions lost as it were in ocean, and amid a world of weaker creatures they seemed to be the sovereigns.

Thirty years ago a discovery of the most unexpected kind produced a real sensation in the scientific world: the bones of birds of gigantic proportions had just been brought to light in the rivers of New Zealand. Nothing more was needed to stimulate men of science, who were exploring the country of the Maoris, with the desire of pushing their researches actively. They excavated in water-courses, marshes, and caves, and bones in considerable quantity were soon found. They obtained the entire skeleton of a bird approaching the giraffe in size, and those of several other species of the same group of smaller dimensions. These remarkable fragments coming into the hands of the eminent English naturalist, Richard Owen, were the subject of continued profound studies. The birds of New Zealand, extinct at an epoch doubtless very near our own, and yet known to us only by relics, have been called the *Dinornis;* the species of largest size has received the name of gigantic dinornis. The English explorers, finding the bones of dinornis in the beds or on the banks of rivers, often mixed with the bones of animals yet living in the country, or with those of man even, sometimes in cavities full of ashes and charcoal, where food had been prepared, were convinced that these relics came from individuals whose destruction was recent. The hope occurred to every one of finding yet living specimens either in the woods or the mountains, encouraging them to scour the country; but all researches till now have remained unsuccessful. The natives of New Zealand, asked a thousand times about the origin of these bones of

enormous size found abundantly in so many localities, answered generally that the remains were those of a sort of bird known among them as the *moa*. The Maoris often declared that moas still existed in certain parts of the mountains; several pretended to have seen them, perhaps by way of boasting, for no precise fact occasioned the assertion to be taken as expressing the truth. Still, a vague tradition does seem to have been kept up among the native New-Zealanders with regard to enormous extinct birds.

The dinornis had marked relations with ostriches, and yet more so with cassowaries; in a word, they belonged, at least the greater part of them, to that family of running birds called *Struthionids*. The comparison of bones, rigorously made by Richard Owen, leaves no doubt on this point. New Zealand was formerly inhabited by numerous species of dinornis, perfectly distinct from each other, and varying much in their proportions. The gigantic dinornis we have mentioned might attain the height of more than eleven feet; other species were of the height of an ostrich, or less, and others had a much more massive shape and a slow gait, as is proved in the elephant-footed dinornis (*Emeus elephantopus*) by the thick, stout, enormous leg-bones. Each species inhabited a very limited region; the dinornis of North Island and that of Middle Island were not the same, and many of them seem to have lived in a very narrow space. Incapable of flying or swimming, these animals had very sedentary habits. Though it is proved that the great birds of New Zealand must for the most part present close resemblances to the cassowaries, the fact is less certain for some species.

We have observations, descriptions, and even sketches of the birds of the Mascarene Islands, derived from travelers of more or less learning; vague descriptions indeed, sketches often very imperfect, which yet have become precious. They give us at least a general idea of the look, the gait, the colors and habits of the lost animals. We have nothing like this as to the birds of the Austral Islands; some scattered bones, merely, have enabled us to reconstruct skeletons, and to frame comparisons with the nearest species existing in other countries. If the extinct creature differed but slightly in its forms from a well-known living species, the relations are easily established by that single comparison; the differences appear readily to the eye of a practised naturalist, an almost exact notion of the extinct being is gained, a sort of new life seems given to the creature whose mere relics have been seen. On the contrary, if the animal to be reconstructed had very peculiar characteristics, or in its general form proportions unknown elsewhere, it becomes impossible to reach a satisfactory result. We attempt to call the animated being before us in thought, but reflection tells us that the image cannot be a faithful one. This is probably the case with some of the extinct birds of New Zealand.

The question has been asked whether the hope of finding any liv-

ing dinornis can be seriously entertained; on this point the affirmative and negative have both been maintained by zoologists, and especially by the explorers of New Zealand, who, better than any one else, can give reasons for their view. Dr. Thomson, who has made a special study of the spots and caves from which an immense number of bones of these great birds has been taken, is convinced that the famous moas of the Maoris were extinct at least two centuries ago, and will be looked for now in vain, and the proofs he brings in support of this opinion are serious enough to inspire fears lest his prophecy be correct. The taking possession of the New-Zealand Islands by the Maoris is generally assigned to the fifteenth century, and in countries not inhabited by mammals the early settlers must have hunted the great birds, that yield immense supplies of food, in an unsparing way. Under such circumstances how could the destruction of the dinornis have failed to be rapid and very quickly effected? Tasman, who discovered New Zealand in 1642, gained no information on the subject of the moas, although this fact is unimportant, since he maintained very slight relations with the natives; but their silence in intercourse with other navigators is more significant. Cook explored the country three times, established communication with the inhabitants, had conversations with the great chief Rauparaha, and thus must have known the popular traditions; yet nothing was ever said of gigantic birds. Dumont d'Urville, a sagacious man, anxious to investigate the life of the tribes he visited, studied the habits and customs of the Maoris; he fixed his attention on the plants and animals of New Zealand, and nothing led him to suspect the existence of the dinornis. According to Dr. Thomson, the native traditions on this subject are absolutely vague, and bear witness merely to the fact that there were moas living at the same time with the men of the race now inhabiting the country. No Maori of this day professes to have seen a moa moving about the woods or the plains. The state of complete preservation in which certain remains have been found must be attributed, the same author believes, merely to the peculiarities of the soil in which they were buried.

Now, those who do not give up the hope of finding some living dinornis, at some time, rely on several indications which perhaps must not be altogether disregarded. The Rev. Mr. Taylor affirms that the Maoris have traditions about the moa-hunts of their ancestors, and songs celebrating the hunters' exploits. Some travelers assert that they have had positive declarations from the natives of the presence of gigantic birds in the mountains; others declare that they have seen moas, but always ran away in terror at the sight of those strange animals; and others still suppose that they have seen tracks on the ground indicating the passage of an enormous bird. It is impossible to put much confidence in such stories, but observations on the condition of certain remains are much more striking. On the 16th of June, 1864,

the Linnæan Society of London listened to the reading of a curious memoir by Mr. Allis, on the discovery of a nearly complete skeleton of the dinornis. This skeleton, found by some gold-hunters under a mound of sand near Dunedin, in the province of Otago, was in an astonishing state of preservation. Cartilages, tendons, and ligaments, were still adhering to the bones; a part of the skin, still undestroyed, contained quills of parted feathers like those of the emu, a kind of cassowary; the feather part of some of these remained. A very experienced zoologist judged that the animal had very probably not been dead more than ten or twelve years. A last point for reflection, as to the existence of dinornis at the present day, is given us by a distinguished naval officer, Commander Jouan, who has made a great number of interesting observations during his long voyages. This accomplished navigator tells us that there are solitudes in Middle Island into which the Maoris, and of course Europeans, have never penetrated, and the interior of North Island is little known beyond the valleys, the bottom of which is occupied by water-courses, which allow traveling by canoes, or at most by pirogues. Therefore, great birds might still have safe retreats. If the extinction of the dinornis is not utter, it seems certain at least as to most species of the group.

Other New-Zealand birds of moderate size seem to be threatened in their turn with complete destruction in the near future. The brown-feathered apteryx, with long, curved beak and stout feet, are very much pursued since the colonization. These walking-birds, having their vestiges of wings even smaller than ostriches and cassowaries, unable to escape by swift flight, live on the ground, and merely hide themselves in holes. Dogs trained to pursue them easily make them a prey, and the poor apteryx has already almost vanished from the inhabited country; their destruction will be complete with the advance of colonization. A singular parrot, of the size of a common fowl, the *strigops*, peculiar to New Zealand, formerly quite common, but now extremely rare, is also doomed to perish. The strigops, a true parrot in all characteristics, an owl in its habits, dull in movement and plumage, is the only nocturnal species of the parrot family, and for that reason extremely interesting to zoologists. This bird, light-green in color, streaked with black lines, flies but little; it runs along the ground and takes refuge in holes; the object of constant attack by dogs and men, it exists nowhere but in solitudes as yet inaccessible. The rarity of the native birds becoming every day more marked in New Zealand, many persons have supposed that the rapid disappearance of the most remarkable species might be accounted for by a lowering of the temperature. They have forgotten that the apteryx and the strigops do very well in the present state of the country, wherever they are not disturbed.

Among the creatures whose recent disappearance is very probable without being actually certain, is reckoned a bird of Madagascar, ex-

ceeding the gigantic dinornis in size. The first important discovery of remains left by this lost species is quite recent. It was announced to the French Academy of Sciences by Geoffroy Saint-Hilaire, the 27th of January, 1851. Enormous eggs brought to France by Alfred Abadie, captain of a merchantman, excited amazement in every one, *savants* and ignorant alike. These eggs, six times as large as an ostrich's, and equal to 148 hen's-eggs, had a capacity of more than 1¾ gallon. Nothing more astonishing had ever been seen. From a few scattered bits of bones found in the same spot, Saint-Hilaire traced vestiges of the bird to which the eggs must be attributed, and designated the animal by the name of the *Æpyornis maximus*. The island of Madagascar presenting so extended a surface, unexplored in all parts, it was readily believed that the æpyornis might still be wandering over its vast solitudes, for in Madagascar, as in New Zealand, the natives speak of enormous birds as existing in the woods and mountains. Since the last exploration of the great African island, this seems an improbability. An intelligent young naturalist, Grandidier, made a voyage to Madagascar a few years ago; after gaining much information, he returned once more to the region which promised new discoveries. Quite lately, while making excavations in the midst of a marshy tract in Amboulisate, on the west coast of the island, Grandidier had the good fortune to collect some bones that seem to belong to the bird with those incomparable eggs. These fragments, it is true, are nothing more than two vertebræ, a thigh-bone, and a leg-bone; they enabled Milne-Edwards to demonstrate the relationship of the æpyornis with the ostrich, cassowary, and dinornis, and to prove the fact that the Madagascar bird, with a heavier body and stouter legs than any of the dinornis had, yet was not so high in stature as the largest species of New Zealand. Remains of the æpyornis of inferior size found in small quantity disclose, moreover, the existence of several species belonging to the same type, and inhabiting the same region at an area doubtless not very remote.

Every one in France and other parts of Europe is aware of the rapid decrease of birds. The larger kinds will, perhaps, be exterminated before a century passes. The bustard, which, in Buffon's time, was commonly enough found in the plains of Poitou and Champagne, is now extremely rare. The tétras, better known under the name of the great heath-cock, formerly abundant in our forests, is now found only in a few localities. Game so superb offers irresistible temptations to sportsmen.

In past ages the great auks (*Alca impennis*), fitted for swimming, but unable to fly, abounded on the shores of the arctic regions; they have been destroyed, annihilated. At a rather remote period they were common on all the coasts of Scandinavia, as in the Orkney and Faroe islands, and on the banks of Newfoundland; at a date nearer our own, they were still frequently seen in Lapland and Greenland;

in the first years of the present century they only existed in some unfrequented northern islands. For thirty or forty years past, not a single one has been seen anywhere. The great auk figures stuffed in some museums of natural history; it is now an object of priceless value. A bird of the size of a goose, having the upper parts of its body velvet-black, its throat shaded with brown, and its lower parts white, the auk presents zoological marks of peculiar interest; it is intermediate between the lesser auk, a flying bird, which visits our shores in winter, and the penguins of southern lands. The great auk formerly furnished the people of the north with a large part of their food. Steenstrup has found thousands of bones of these birds, gnawed, splintered, and scratched, among the famous refuse-heaps of Denmark and Norway, which he has dug into with great service to information for history. In many places, penguins made the principal food of the ancient Scandinavians; later in time, these birds and their eggs, gathered by thousands in the breaks and crevices of the rocks, were a resource for sailors, and of all that abundance there remains nothing, absolutely nothing. Birds, as we see, have already lost many members of their family.

The destruction of the great animals, effected by men within a few centuries, leads us to anticipate a serious impoverishment of Nature in a more or less remote future. The extinction of a multitude of species has taken place with deplorable rapidity in the Mascarene Islands; it is going on in many other parts of the globe. Singularly, wherever European civilization penetrates, devastation begins, and sooner or later is completed. The most industrious nations are the greatest ravagers. A few thousand years more, and the whole earth will present a uniform and wretched appearance.

The facts we have just recalled, as to beings exterminated by man, lead the mind to reflections on the primitive state of our present world. In the Mascarene Islands, in New Zealand, a special fauna, entirely different from that of the countries nearest them, proves that these islands have remained isolated since the appearance of the animals that inhabit or did till lately inhabit them. The presence of birds unable to fly, or to defend themselves effectually in countries where no dangerous enemies are to be feared, is the indication of a regular assignment of organism to determinate locations, for one who does not believe in indefinite transformations perceptible only to the imagination. Finally, in seeing animals wanting effective means of locomotion established in limited ranges, we are led to believe that each species at first lived only on some very small part of the globe, and that the varying distribution of individuals results chiefly from the enlargement of locomotive powers.

# THE MOQUIS INDIANS OF ARIZONA

By Dr. OSCAR LOEW,
CHEMIST TO WHEELER'S SURVEYING EXPEDITION.

AMONG the aboriginal tribes of the Southwest is that of the Moquis, an isolated remnant of a former wide-spread nation. These Indians are of particular interest, especially as a study for the ethnologist, on account of their peculiar manner of living, strange customs, etc., as well as in being little known and seldom visited by the white man.

While the literature of American ethnology teems with interesting accounts of the aboriginal race of this country, and is replete with the history of the various other tribes, but little is said regarding the singular and romantic branch of the Pueblos who call themselves "Moquis." Year after year military expeditions have traversed the far West, yet few have been led to the hidden recesses of this tribe; moreover, theirs is a region seldom visited by civilians, and of these the few coming thither are principally New-Mexicans.

It was the sixth day after leaving Fort Defiance, that our party, under Lieutenant Russell (of the "Expedition for Explorations and Surveys west of the One Hundredth Meridian," in charge of Lieutenant George M. Wheeler, U. S. Engineers), began to near the Moquis villages, concerning the inhabitants of which we had listened to so many thrilling and marvelous stories. Immediately before us was spread a wide, sandy basin, whose loose, dusty surface offered no verdure to delight the eye, or relieve the wearisome monotony of the barren landscape. Ten miles away over this trackless desert loomed up, on the western horizon, wide and precipitous cliffs whose heights it would seem impossible to climb. "On those cliffs," said our Navajo guide, "live the Moquis." A few hours later, and we had crossed the sterile waste, and were at the base of the sandstone masses whose outline we had previously traced in the far distance, there to find perched on lofty summits the habitations of the singular people we had come so far to see.

As we approached, human beings began to throng the rim of the precipitous bluffs, their dusky features betraying curiosity over an event so novel and unexpected as the presence of white men at the very threshold of their citadel. We now began the ascent to the villages; a narrow path led, by a serpentine route, up the dizzy heights, and, in single file, we soon gained the summit; not, however, until we had passed several Moquis posted, sentinel-like, along the approach. Once up the steeps, we were soon surrounded by Indians, when, *nolens volens*, a hearty hand-shaking ensued, and friendly intercourse forthwith began.

The home of the Moquis is on a rocky island, separated from the rest of the world by an ocean of sand, and is one of the strongest natural fortifications; indeed, as a stronghold against invasion, it may justly be termed the Gibraltar of the West. Neither the Navajos nor the Apaches, whose tribes have ever numbered some of the most celebrated of Indian warriors, have as yet met with even temporary success in their attacks on the Moquis. Although for several years past these tribes have been on peaceable terms, there is, nevertheless, no special liking the one for the other, and ever and anon bitter recollections of by-gone strifes are openly manifested, and the younger bucks strip for the war-path.

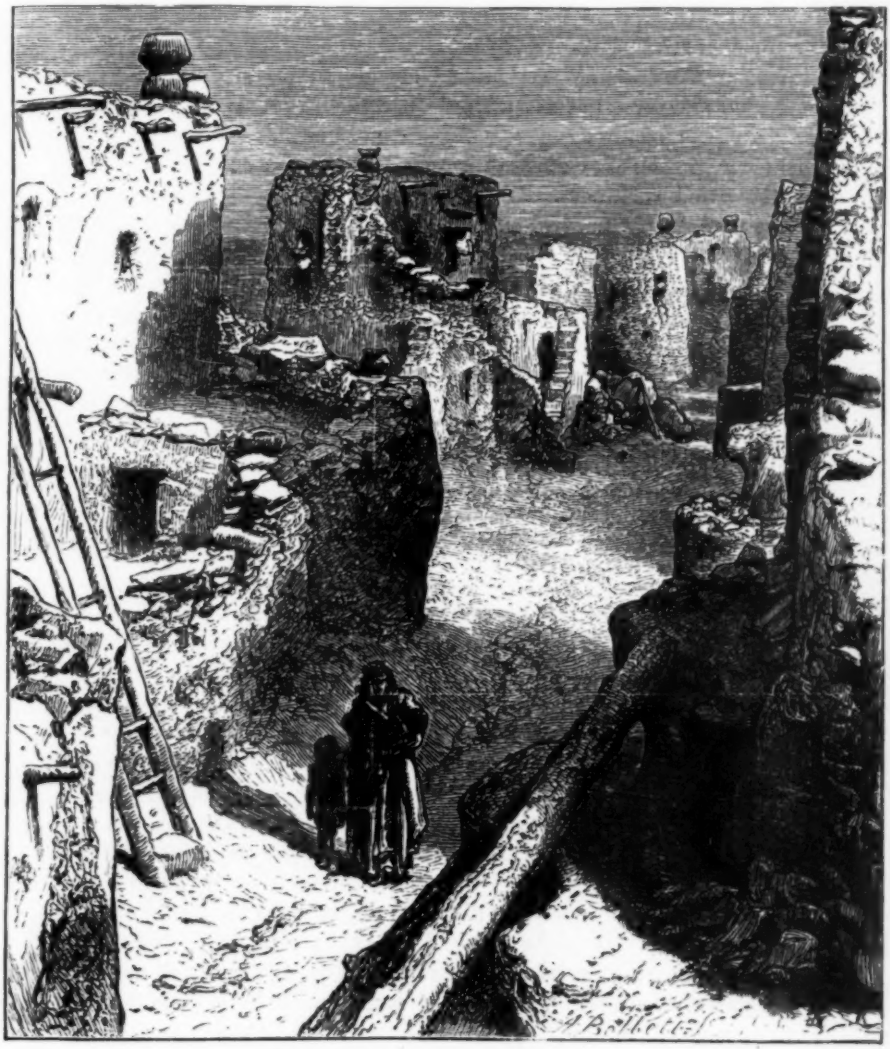
The Moquis number about 2,500 souls, and occupy seven villages, or, speaking accurately, six, one being inhabited by a branch of the Tehuas. These villages are built on the tops of four sandstone *mesas*,[1] which are separate from each other about eight miles. On the first are three of the villages, fifty yards apart. They are named respectively, Tehua, Tsi-tsumo-vi, and Obiki, the last commonly but erroneously called Hualpy. The villages on the second mesa are Mushangene-vi and Shebaula-vi. On mesa number three is Shongoba-vi, and on number four Orai-vi. These villages occupy the entire width of the mesas, and, standing immediately before the houses, one may look vertically down a frightful depth of three hundred feet! In many places the sides of the mesas are terraced, the terraces being used as sheep-corrals. On the rims of these high and rocky walls children may be seen at play, unconscious of danger, while the mother performs the duties of the household apparently thoughtless of the gulf that yawns within stepping-distance of her innocent brood. Below, on the sheep-terraces, other children are delightfully engaged in sucking goat's milk from its *natural* fountain.

As stated, these villages occupy the entire width of the mesas. The houses are built in a row, side by side, and are principally of two (although not a few are of four) stories. They are constructed in a terrace style, the upper stories being removed a few feet back from the lower ones. The mode of entry is by means of ladders or steps cut in the side-walls. These habitations are not built of adobe, of which material the larger number of Indian and Mexican huts are formed, but of stones firmly held in place by a cement of clay and sand. The several stories are, respectively, about seven feet high, and are divided into a number of rooms, each of which is provided with an open fireplace. For windows the walls are pierced in many places, the holes being cut square, and about a foot either way. In severe winters the inhabitants of these houses shelter themselves in cellars or caves in the rocks near by.

In appearance the Moquis resembles the Caucasian rather than the Mongolian race. The facial features are a cross between pleasant and

[1] *Mesa*, table, a flat surface on the top of hills or mountains.

severe, and in many instances the expression is that of unusual intelligence. The complexion is a light red-brown, the teeth snow-white, and hair "jet-black," coarse and long. Everywhere throughout the tribe the pitted skin is evidence that at no remote period in the past small-pox has held its pernicious sway.



STREET IN A MOQUIS VILLAGE.

These Indians are well clad, especially the females, some of whom are neatly attired, particularly the daughters of the chief, who, by-the-by, are exceedingly interesting young ladies. Their dress par-

takes much of that common in the Eastern cities, while the hair is worn in the style known as "Pompadour." One advantage these nymphs of the desert possess over those of the East is, that of being able to carry their head-gear with them when they retire to rest, the whole being the work of Nature in themselves and nothing of art. By reason of the extensive ravages of the small-pox, many of the houses are just now empty, their occupants having fallen victims to a disease whose merciless march they had not the scientific knowledge to stay.

Among the Moquis settlements are found dogs, donkeys, sheep, goats, and chickens, but not a single specimen of the feline tribe, nor a hog, a cow, nor a horse. The donkey is almost indispensable, in that it is their principal means of transporting wood, which has to be brought great distances. In the absence of wood, dried sheep-excrement is extensively used as fuel. Very little grass is to be met with in the vicinity of the mesas, the entire country round about being a vast sand-heap devoid of vegetation. For pasture the sheep are driven off several miles northward to a few patches of poor grass.

The chief article of subsistence of these natives is Indian-corn; they have no meat, excepting occasionally mutton. The sheep are raised for their wool, and not for table-purposes. From the wool they manufacture an extraordinarily good and serviceable blanket.

The atmosphere being very dry, and no rains occurring sometimes for several months, and with no streams near by for irrigating purposes, it may well be inquired how these untutored aborigines, on whom the light of our civilization has not yet dawned, manage to produce the article which furnishes them with the staff of life. The method employed is as follows: The seed is planted at from one to two feet beneath the sand and very wide apart. At this depth they have found by experience that there is sufficient moisture to develop and sustain the plant. On analyzing specimens of the soil, the chemist of the expedition has found that the experience of these untaught Indians is in full accord with the results of his investigations. The interesting fact was elucidated that subsoil at a distance of one foot contains two and two-tenths per cent. of moisture to one per cent. at the surface, from which it may be inferred with reason, that at no great depth there must be a stratum of water. This water, ascending by capillary attraction, is rapidly evaporated as soon as it reaches the surface, on account of the looseness of the soil and the arid atmosphere. Grass-seed scattered over the ground in this region of sand would fail to germinate, and only be wasted. The only water in this locality is that supplied by several small springs at the bases of the mesas.

The bread made by the Moquis has a similarity to our "wafer." In preparing it the corn is ground between two stones to a fine powder, water being subsequently added until the mixture is brought to a thin paste. This paste is spread out with the hand in layers over a hot stone, and in a few moments is ready for eating. Another variety of

their food is prepared from corn that has been germinated, whereby, as is well known, a saccharine matter is developed and a species of malt produced; this food they call *panoche*. Still a third kind is derived by mixing flour and dried meat in a powdered state: this they call *tomales*.

The Moquis have one school, which is provided them by the "great father," and which is attended by children from three to five years old. On being examined, these little ones counted correctly to 100. They are quite proficient in spelling, while their ready recital, without the book, of numerous English verses, showed them possessed of very retentive memories.

As previously mentioned, the Tehuas occupy one of the Moquis villages. The languages of the two tribes, however, are quite different, that of the latter being unintelligible to the former. On collecting a vocabulary of the language of the Tehuas, it was found to be identical with that of the Indians of Ildefonso, who inhabit some twenty-five miles west of Santa Fé, and from three to four hundred miles distant from the Moquis towns. Inquiry as to the date of settlement of the Tehuas with the Moquis proved fruitless of the desired result; the Indians either did not know, or were unwilling to tell. One intelligent Moquis, named Mesayamtiba, who answered many questions readily and very intelligibly, estimated the period of intermingling of the two tribes at upward of one hundred years.

As a refutation of the rather prevalent notion that Indian languages are subject to rapid change, it may be said that, although the Tehuas and Ildefonsos have been separated at least a century, and that, too, at a distance from each other of several hundred miles, the language of the branch tribe is still identical with that of the parent stem. Furthermore, although the Tehuas and Moquis live but fifty yards apart, their dialects are entirely different, that of the former not embracing a single word used by the latter. By this, however, it is not to be understood that some of the Moquis do not understand the Tehuas language, and *vice versa*. Besides their own language, a few of both tribes speak broken Spanish.

With regard to the religion of the Moquis, diligent investigation failed to develop any thing definite. To the inquiry whether they worship Montezuma, the reply was, in broken Spanish, "*No sabe*" ("I don't know"). By Mesayamtiba, we were informed that he believed the "sun to be the true God," but that the so-called "happy hunting-ground" was, in his opinion, but a creation of the imagination—the "baseless fabric of a dream." They have neither church nor other place of worship to be found, which is evidence that the Spanish Jesuits have been unable to gain a foothold among them, although these priests have succeeded in establishing themselves with almost all the other Pueblo tribes, as is plainly shown by the ruins of Jesuit churches in Acoma, Gemez, and other towns. The Moquis sometimes

hold religious meetings in caves in the vicinity of their settlements. On being asked to decipher an hieroglyphical inscription some fifteen miles southeast from their villages, a copy of which was shown them, they appeared unable to do so, replying, "*No sabe.*" The belief is well entertained, however, that they were acquainted with the inscription, and knew its hidden meaning, since there were found in the house of one of the chiefs figures carved in wood which corresponded exactly to some of those employed in the inscription. If these were designed as objects of worship, no profound veneration was manifested for them, since they were readily parted with for a trifling quantity of tobacco.

The exact date at which this singular people settled in Northeastern Arizona, and built their habitations on massive rocks, whose foundations are far beneath the level of the sandy plain which surrounds them, is a question still enveloped in mystery. Taking into consideration the fact that the space between the several villages on one of the mesas is solid rock, and that across this space a path has been worn by human feet to a depth of several inches, and remembering that the shoes of the people who have trod out this stony pathway have been of the softest leather, it is not unreasonable to assume that at least a thousand years have elapsed since this tribe first made its appearance in this bleak and uninviting section of the Western World.

While our visit to the Moquis resulted in much valuable information concerning this remnant of a race fast disappearing from the face of the earth, we were otherwise well repaid for the hardships we had encountered in reaching this isolated spot, and shall not soon forget the pleasant hours spent in the company of these half-civilized beings. As evening drew near, sitting on the tops of the lofty mesas, our fevered brows were gently fanned by cooling breezes, which soon caused us to forget the tropical heat of the day, while our eyes were feasted by a sunset seldom equaled in grandeur and sublimity. The sinking sun produced a golden hue around the summits of the far-distant Sierra de San Francisco, while its light, reflected along the horizon, transformed the sky into an ocean of blood. It was long after nightfall ere wearied nature sought repose; but, at last, we retired to rest, with naught but rock for our pillow, and with no roof above us save the blue canopy of Nature, which seemed more than ever fretted with twinkling stars.

# MENTAL EVOLUTION AND NECESSARY TRUTHS.[1]

By HERBERT SPENCER.

I AM not about to continue a controversy which I regret having been provoked into by the misrepresentations of one who ignored the contents of works he professed to review. Reply and rejoinder may go on endlessly. I could not, to much purpose, argue with Mr. Hayward, who, instead of taking such unconsciously-formed preconceptions as those resulting from the infinite experiences of muscular tensions and their effects, proposes to exemplify unconsciously-formed preconceptions by a consciously-formed hypothesis concerning the relation between weight and motion. Nor should I care to discuss any question with my new anonymous assailant; who, when certain examples given show the "exact quantitative relations" spoken of to be those of direct proportion, describes me as "intensely unmathematical" because I subsequently use the more general expression as equivalent to the more special—which, in the case in question, it is.

The first of my objects in now writing is to remind "some by-standers, who may from their antecedents be presumed competent to judge," that the essential question is not a mathematical one, but a logical and psychological one, in respect of which I am not aware that senior wranglers, as such, can claim any special competence. Further, even admitting the assumption that the question is mathematical, I have to warn the reader that he will be much misled if he infers that there are not "some by-standers who may from their antecedents be presumed" *more* "competent to judge," who concur in the opinion that the laws of motion cannot be demonstrated experimentally.

My second object is to inclose, for publication in *Nature*, a passage now standing in type to be added to future impressions of "First Principles" in further elucidation of necessary truths, and our apprehensions of them:

"The consciousness of logical necessity is the consciousness that a certain conclusion is implicitly contained in certain premises explicitly stated. If, contrasting a young child and an adult, we see that this consciousness of logical necessity, absent from the one, is present in the other, we are taught that there is a *growing up* to the recognition

[1] [The article published last month, to which we gave the title of "Punishing a Senior Wrangler," was issued by Mr. Spencer in a pamphlet as a part of his "Replies to Criticism." It led to a running fight in the columns of *Nature*, which we have not printed. A second "Senior Wrangler" having come to the rescue of the first, with assurances of his "sympathy," and R. B. Hayward having pitched in, Mr. Spencer sends the above communication to *Nature*, which we reproduce, because of the permanent interest of his argument.—Ed.]

of necessary truth, merely by the unfolding of the inherited intellectual forms and faculties.

"To state the case more specifically: Before a necessary truth can be known as such, two conditions must be fulfilled. There must be a mental structure capable of grasping the terms of the proposition and the relation alleged between them; and there must be such definite deliberate mental representation of these terms as makes possible a clear consciousness of this relation. Non-fulfillment of either condition may cause non-recognition of the necessity of the truth; and may even lead to acceptance of its contrary as true. Let us take cases.

"The savage who cannot count the fingers on one hand, can frame no definite thought answering to the statement that 7 and 5 make 12; still less can he frame the consciousness that no other total is possible.

"The boy adding up figures inattentively, says to himself that 7 and 5 make 11; and may repeatedly bring out a wrong result by repeatedly making this error.

"Neither the non-recognition of the truth that 7 and 5 make 12, which in the savage results from undeveloped mental structure, nor the assertion, due to the boy's careless mental action, that they make 11, leads us to doubt the necessity of the relation between these two separately-existing numbers, and the sum they make when existing together. Nor does failure from either cause to apprehend the necessity of this relation make us hesitate to say that, when its terms are distinctly represented in thought, its necessity will be seen; and that, apart from any multiplied experiences, this necessity becomes cognizable when structures and functions are so far developed that groups of 7 and 5 and 12 can be intellectually grasped.

"Manifestly, then, there is a recognition of necessary truths, as such, which accompanies mental evolution. Along with acquirement of more complex faculty and more vivid imagination, there comes a power of perceiving to be necessary truths what were before not recognized as truths at all. And there are ascending gradations in these recognitions. Thus a boy who has intelligence enough to see that things which are equal to the same thing are equal to one another, may be unable to see that ratios which are severally equal to certain other ratios, that are unequal to each other, are themselves unequal; though to a more developed mind this last axiom is no less obviously necessary than the first.

"All this, which holds of logical and mathematical truths, holds, with change of terms, of physical truths. There are necessary truths in Physics, for the apprehension of which, also, a developed and disciplined intelligence is required; and, before such intelligence arises, not only may there be failure to apprehend the necessity of them, but there may be vague beliefs in their contraries. Up to comparatively

recent times, all mankind were in this state of incapacity with respect to physical axioms; and the mass of mankind are so still. Various popular notions betray inability to form clear ideas of forces and their relations, or carelessness in thinking, or both. Effects are expected without causes of fit kinds; or effects extremely disproportionate to causes are looked for; or causes are supposed to end without effects. But though many are thus incapable of grasping physical axioms, it no more follows that physical axioms are not knowable *a priori* by a developed intelligence, than it follows that there is no necessity in logical relations because many have intellects not developed enough to perceive the necessity.

"The ultimate physical truth of which clear apprehension is eventually reached is, that force can neither arise without an equivalent antecedent, nor disappear without an equivalent consequent. Along with power of introspection there comes recognition of the fact that existence cannot be conceived as beginning or ending: the Laws of Thought themselves negative any such mental representation. And if it be asked why this intuition, which all physical axioms indirectly imply, and which is postulate in every physical experiment, is to be taken as authoritative because its negation is inconceivable, the answer is that no argument which sets out to discredit it can do this without logical suicide; since there is no other warrant for asserting the dependence of any conclusion on its premises than the inconceivability of its negation."

This passage forms part of a revised version of the chapters on Matter, Motion, and Force, which I have contemplated making for this year past. When those chapters were written and stereotyped, in April, 1861 (*see* Preface), the modern doctrines concerning Force and its transformation were so imperfectly developed, that some of the leading technical words now currently used were not introduced. The reorganization of "First Principles," which I made in 1867, for the purpose of more truly presenting the general Theory of Evolution, did not implicate these chapters, and I believe I did not even re-read them: the stereotype plates, in common with those of many other chapters, with the numberings of pages and sections altered, were used afresh, and continue still to stand as they originally did. But while now rectifying defects of statement which it was scarcely possible to avoid thirteen years ago, I find no reason for changing the essential conception set forth in those chapters; nor is the need for changing it suggested to me by those on whose judgments I have the best reasons for relying.

## SKETCH OF DR. THOMAS YOUNG.

ON a slab in Westminster Abbey, surmounted by a profile medallion, the work of Chantrey, there is the following inscription:

SACRED TO THE MEMORY OF

THOMAS YOUNG, M. D.,

FELLOW AND FOREIGN SECRETARY OF THE ROYAL SOCIETY,
MEMBER OF THE NATIONAL INSTITUTE OF FRANCE;
A MAN ALIKE EMINENT
IN ALMOST EVERY DEPARTMENT OF HUMAN LEARNING.
PATIENT OF UNINTERMITTED LABOR,
ENDOWED WITH THE FACULTY OF INTUITIVE PERCEPTION,
WHO, BRINGING AN EQUAL MASTERY
TO THE MOST ABSTRUSE INVESTIGATIONS
OF LETTERS AND OF SCIENCE,
FIRST ESTABLISHED THE UNDULATORY THEORY OF LIGHT,
AND FIRST PENETRATED THE OBSCURITY
WHICH HAD VEILED FOR AGES
THE HIEROGLYPHICS OF EGYPT.

The subject of this eulogy was one of the most remarkable men in the annals of British science and literature—according to Prof. Tyndall, the greatest man of science that had appeared since Newton; and, as his biography has never been republished in this country, a brief sketch of his life will be fresh and instructive to many.

THOMAS YOUNG was born in 1773, and died in 1829. He was the eldest son of ten children. His parents were both members of the Society of Friends, and strict observers of the principles of their sect, in which their children were carefully educated. Dr. Dalton, the eminent English chemist, was also of Quaker parentage and education; but, while he continued through life to retain his membership of the denomination and to conform to its principles, Dr. Young held the tenets and conformed to the observances of the Society only during his youth. He was a very precocious child. At two years of age he could read with fluency, and had read the Bible twice through before he was four years old. At six years of age he could repeat Goldsmith's "Deserted Village," and had previously begun his Latin grammar. At seven years of age he was sent to a miserable boarding-school, but the next year at the house of a friend he came across a "Dictionary of Arts and Sciences," which he perused with intense interest, and also got instruction in the use of some mathematical and philosophical instruments. When nine years old he was sent to another school, where he remained four years, and made great proficiency in classics, mathematics, and natural philosophy. He also learned the principles of drawing, the art of book-binding, the construction of mi-

croscopes, telescopes, and electrical machines, and the use of the lathe. In an autobiographical sketch, he says that, after returning home from this school, he devoted himself almost entirely to the study of Hebrew, and to the practice of turning and telescope-making. He borrowed and studied with great diligence the Chaldee, Syriac, Samaritan, and Persian grammars, and, having got hold of the Lord's Prayer in a hundred different languages, was greatly interested. At fourteen years of age Young became tutor to Mr. Hudson Gurney, who was a year and a half older, and who continued his friend through life, and wrote a biography of him. He wrote a beautiful hand, and, when once requested by a friend of his uncle, Dr. Brocklesby, an eminent London physician, to exhibit a specimen of his handwriting, he wrote a sentence in fourteen different languages. His precocity reminds us of that of J. S. Mill, but it had a far more spontaneous and varied exercise. He went on with his mathematical, botanical, and entomological studies with great ardor, but he was left to entire freedom in their pursuit, and believed that "whoever would arrive at excellence must be self-taught;" and that there was "in reality very little that a person, seriously and industriously disposed to improve, may not obtain from books with more advantage than from the living instructor." Upon this principle, as his biographer remarks, he was self-taught. "He read nothing hastily or cursorily, and his memory was so tenacious that he never forgot what he had once mastered. He wrote exercises and composed in the languages in which he studied. His journals were written in Latin, and his criticisms on French authors in French, and on Italian authors in Italian. His mathematical studies were carried on in a similar manner. He began the six books of Euclid on such a day, and finished them on another; and we hear no more of them. Algebra, trigonometry, and fluxions were dispatched in the same way. He read the 'Principia' deliberately through; and it appears from the remarks in his journals that he had fully comprehended them."

At nineteen years of age, in obedience to the wishes of his uncle, Mr. Young entered upon the study of anatomy and medicine, and from the outset he became an original investigator in this field, his first researches being into the structure of the eye as an optical instrument. At the age of twenty-one, the Duke of Richmond offered him the appointment of his private secretary, at $1,000 a year, and "a place at the duke's table." This he declined on the ground of Quaker scruples, and wrote to his mother that he "was not ashamed to allege his regard for the Society as a principal reason for not accepting the proposal. . . . This event in his life led him, no doubt, to consider how far his position as a Quaker might interfere with his future prospects. He had hitherto adopted their garb and phraseology, but he now began to divest himself of these characteristics, and to mix largely with society. In Edinburgh, where he went at the close of 1794 to prosecute his medical education, he did not scruple to violate the principles of his

sect. He spent much time at parties, both grave and gay; went frequently to the theatre in spite of the remonstrances of his friends, took private lessons in dancing and in playing on the flute."

After prosecuting his medical studies in Edinburgh, he made a thorough tour of Scotland at the close of the session of 1795, and returning to England went at once to Göttingen, "where, along with his medical studies, he took lessons in drawing, dancing, riding, and music, in all of which he made rapid progress. He was passionately fond of horsemanship, and there were no feats in that art too daring for him to accomplish."

In 1797 his uncle, Dr. Brocklesby, died, leaving him his house, library, collection of prints and pictures, and fifty thousand dollars in money, which enabled him to pursue his inquiries with greater facility, and in the beginning of 1800 he commenced the practice of medicine in London. In 1801 he was appointed Professor of Natural Philosophy in the Royal Institution of Great Britain, and he conducted its journal along with Humphrey Davy, then Professor of Chemistry. The first year he gave thirty-one lectures, and afterward sixty, which were published in 1807, in two quarto volumes, under the title of "A Course of Lectures on Natural Philosophy and the Mechanical Arts," a work which, notwithstanding its obscurity both in language and in thought, is rich in original and ingenious views, and of inestimable value to the student of physics and the mechanic arts.

It was in May, 1801, when Dr. Young was twenty-eight years of age, that, reflecting on the experiments of Newton, he was led to the discovery of a law which "appeared to him to account for a greater variety of interesting phenomena than any other optical principle that had yet been made known." This was the law of the Interference of Light, which he explained on the principle of the undulatory theory. This theory had been long before propounded by Huyghens and Hooke, but Dr. Young revived it, gave it greater precision of form, and first proved that it accounts for luminous phenomena which can be explained by no other known hypothesis. His views were developed in *Nicholson's Journal* for 1801, in the following propositions:

"I am of opinion," says he, "that light is probably the undulation of an elastic medium, because—

"1. Its velocity in the same medium is always equal.

"2. All refractions are attended with a partial reflection.

"3. There is no reason to expect that such a vibration should diverge equally in all directions, and it is probable that it does diverge in a small degree in every direction.

"4. The dispersion of differently colored rays is no more incompatible with this system than with the common opinion, which only assigns for it the nominal cause of different elective attractions.

"5. Reflection and refraction are equally explicable on both suppositions.

"6. Inflection is as well, and, it may be added, even much better, explained by this theory.

"7. All the phenomena of the colors of thin plates, which are in reality unintelligible on the common hypothesis, admit of a very complete and simple explanation by this supposition. The analogy which is here superficially indicated will probably soon be made public more in detail; and will also be extended to the colors of thick plates, and to the fringes produced by inflection, affording from Newton's own elaborate experiments a most convincing argument in favor of this system."

Regarding medicine as an inductive branch of philosophy, Dr. Young drew up an "Introduction to Medical Literature, including a Practical System of Nosology," which Dr. Peacock, his latest biographer, says, bears much the same relation to the medical sciences that his lectures on natural philosophy bear to the mathematical and physical sciences. It appeared in 1813, and in an Appendix he gave a sketch of animal chemistry, translated from the Swedish of Berzelius by the aid of a grammar and dictionary, without any previous acquaintance with the language.

In the field of philological exploration, Dr. Young exhibited talents of a very high order. He was especially skillful in deciphering manuscripts and inscriptions which had baffled the ingenuity of his predecessors. "The attention of Dr. Young was first devoted to hieroglyphic research by a papyrus in Egyptian characters, submitted to him in the spring of 1814, by Sir W. Rouse Boughton, found in a mummy-case in a catacomb near Thebes. The papyrus was written in cursive Egyptian characters, and Dr. Young's notice of it was appended to a communication, by its discoverer, to the Antiquarian Society. Between May and November of the same year, he analyzed the three inscriptions of the well-known Rosetta Stone, and gave a conjectural translation of the second of the three, which was added to the notice above mentioned." Champollion, the great French antiquarian, was the rival of Young in the work of unraveling the old inscriptions, and a warm controversy grew out of their respective claims which was not free from the tinge of national feeling. Both were men undoubtedly of great originality, and made their discoveries independent of each other. "Dr. Young never failed to do justice to the sagacity, the extensive learning, and the deep research of Champollion; and his own merits were nobly recognized by the countrymen of his rival, when, in 1828, they elected him one of the eight foreign associates of the Institute of France."

About the year 1810 Dr. Young took up the subject of naval architecture, and contributed important improvements to the construction of ships-of-war. In 1816 he was appointed secretary to a commission for ascertaining the length of the second's pendulum, and drew up the three reports which were made in 1819, 1820, and 1821. In 1818 he was appointed superintendent of the *Nautical Almanac*. He had, some years previously to this, gone into the subject of life-assurance, and worked out mathematically the formula of the value of life, and

the laws of mortality. He wrote a great number of papers on many subjects in the *Quarterly Review* and in the *Encyclopædia Botanica*. As the undulatory theory of light gradually made its way, being fortified in a remarkable manner by the discoveries of Fresnel, the French physicist, there grew up an increasing recognition of the claims of Dr. Young in regard to the subject. Of his distinguished merits and their ultimate recognition, Dr. Peacock remarks:

"On the 6th of August, 1827, he was elected one of the eight foreign associates of the Academy of Sciences, at Paris, in the place of Volta. The other competitors named were the great astronomers Bessel and Olbers; Robert Brown, the botanist; Sœmmering, the anatomist; Blumenbach, the naturalist; Leopold von Buch, the geologist; Dalton, the chemist; and Plana, the mathematician. This is the greatest honor that can be conferred on a man of science.

"The propriety of the selection which was made by the Institute of France, of Wollaston, Davy, and Young, as the most eminent representatives of English science in that age, was disputed by very few of their contemporaries who were capable of forming a correct opinion.

"The lapse of a quarter of a century, since the grave—within the brief space of six months—closed upon the labors of these three eminent philosophers, has somewhat changed the order in which they were classed by their contemporaries. If Young held the lowest place in the order of precedence then, he unquestionably occupies the highest now. The most brilliant achievements of Davy, whether considered singly or collectively, are probably surpassed in importance by the discovery and demonstration of the interference of light; but while the first received the prompt and unhesitating acknowledgment of the scientific world, and at once secured for their author the honors and rewards which were due to his merits, the second, even after emerging from a long period of misrepresentation and neglect, had to make its way, step by step, as it were, and with various and fluctuating fortunes, against the opposition of adverse and long-established theories, supported by the authority of the two greatest men known to the scientific history of the past and present age."

In the summer of 1827 Dr. Young's health began to decline, and in 1829 he suffered from repeated attacks of asthma, accompanied with great oppression and weakness. He sank gradually, and expired without a struggle, May 10, 1829, aged fifty-six. His disease proved to be an ossification of the aorta, which must have been in progress for many years. Every appearance indicated an advance of age not brought on by the natural course of time, but probably by unwearied and incessant labor of the mind from the earliest days of infancy. We have barely touched upon some of the points of the life of Dr. Young, and, to those who care to pursue it further, we can recommend his admirable biography by Dr. Peacock, published by Murray, of London.

# EDITOR'S TABLE.

### *WHO ARE THE PROPAGATORS OF ATHEISM?*

THE hope is indulged by many that, with the progress of intelligence and the increase of liberal feeling, the old conflict between religion and science will either die away, or lose so much of its rancorous spirit that it may be coolly and rationally considered, like any other question. But there are parties who do not seem to think this result desirable, and do all they can to perpetuate the acrimonies that have marked this controversy in the past; and, while we will not say that this bad spirit is all on one side, we will say that the most of it and the worst form of it *are* on one side, and that the side which makes special pretensions to a higher guidance and the loftier virtues. There are religious teachers who habitually make use of science as a scarecrow and bugbear to arouse popular prejudice, and, in doing this, they have not the smallest possible scruple in their representations. We ask attention to the latest illustration of these tactics.

It may be news to some of our readers that there has recently been a vicious attack, on the part of divers religious editors, upon the revised edition of APPLETONS' CYCLOPÆDIA, now going through the press, on the ground that the work is being done in the interests of Romanism. As that charge begins to grow stale, a new cry is raised by the same parties, that the CYCLOPÆDIA is being revised in the interest of atheism. The first attack did not interest us, both because our enthusiasm has never run in the direction of ecclesiastical history, and because we knew the character of the men engaged in the revision to be a perfect guarantee for the intelligent, impartial, and thorough performance of their duty to the public. The revisers of the CYCLOPÆDIA are our nearest neighbors, and their proceedings have interested us from the beginning. What have especially and constantly attracted our attention have been, the vigorous discipline maintained in carrying on the work, and the incessant solicitude and inflexible determination manifested to make it, in the highest degree, truthful and trustworthy. Knowing this so well, we had not the slightest apprehension that a petty onslaught, inspired by sectarian jealousy, could seriously affect the character of the work with the intelligent class to which such a CYCLOPÆDIA must mainly appeal. But in this second attack, which is of wider import, we find ourselves personally implicated, and it therefore becomes proper to notice it; and, when we have shown what it amounts to, the reader will have a pretty good basis for judging the quality of other criticisms emanating from the same source.

In a late number of the *Christian at Work*, a newspaper edited by the Rev. De Witt Talmage, there is a leading article which contains the following passages:

"In the fifth volume of the new and revised edition of APPLETONS' CYCLOPÆDIA, Prof. E. L. Youmans, treating of the Correlation of Forces, says: 'Therefore, it is now regarded as a fundamental truth of physical science, and a fundamental law of Nature, that force, *like matter*, is never created or destroyed.' To affirm that matter is never created, is to affirm that it is eternal. If God and matter are coeternal, then they are identical; and if identical, it follows that God is but an impersonal force acting in and through the inherent properties of matter.

"We are sorry to see APPLETONS' CYCLOPÆDIA giving its sanction to a doctrine so thoroughly unscientific and radically anti-christian.

"Last week we were compelled to show that APPLETONS' CYCLOPÆDIA had made some very gracious concession in the field of history to the behests of Romanism. If it is

also to lend its aid to the propagation of scientific atheism, the sooner we know it the better.

"The interests of truth are paramount; and that publication is not trustworthy which perverts history in the interest of Romanism, or science in the interest of atheism."

The *Catholic Review*, which was probably aware how much terror there was in the "No popery" alarm, and ought to have learned a little caution, joins the *Christian at Work* in getting up the new scare, and, after making the same quotation from our article, observes: "In other words, Prof. Youmans is allowed, in a work intended for education and general uses, to broach the fundamental heresy that there is no personal God." As an indication of how far Catholics and Protestants are animated by the same spirit, we may note that, when the writers of these articles had been rebuked for their course by other newspapers, they both returned to the subject, and repeated the charges in subsequent issues.

Now, of this formidable indictment we have only to say that it is entirely trumped up, and is without the shadow of a foundation in fact. In preparing an article for the CYCLOPÆDIA, on the "Correlation of Forces," we first gave a brief sketch of the investigations that had been made during the past century, and which have brought the whole scientific world to the comparatively new conclusion that, although the different forms of force are convertible, force, or energy itself, is indestructible. After this preliminary statement of the results of experimental investigation, we said, "*Therefore*, it is *now* regarded as a fundamental truth of physical science, and a fundamental law of Nature, that force, like matter, is never created or destroyed." The proposition is stated as an inference, as an induction from observations, as a result of experimental inquiry into the physical processes of Nature, and as a pure principle of science. We were not discussing the subject of matter, but of force, and what we declared in regard to force we assumed in regard to matter that, so far as science knows, it is never either created or destroyed. We did not say that matter is eternal; we did not say that matter never was created, for these are questions beyond the limits of science. We avoided all theological implications, and did not go a hair's-breadth beyond the strict inductive conclusion that in the course of Nature there is no evidence of its creation or destruction. For us there is only one question: Was the statement true? That matter "is never created or destroyed," has been established "as a fundamental truth of physical science and a fundamental law of Nature" for more than a hundred years, or ever since the science of chemistry was founded. Every fact known to chemists or physicists confirms it, and not a solitary fact casts even the slightest doubt upon it. There cannot be shown a particle of evidence within the whole sphere of physical science that a single atom of matter is ever either created or destroyed. The proposition, although for thousands of years it was not believed, is now the corner-stone of all science. If the statement that matter is indestructible be not a truth of physical science, then there are no truths of physical science; if it be not a fundamental law of Nature, then there are no fundamental laws of Nature. The doctrine which we laid down has been held as a demonstration in the whole scientific world, and has become elementary in all our text-books, for generations.

But, for stating it in the AMERICAN CYCLOPÆDIA, that work is charged with being a perverter of science, radically antichristian, and a propagator of atheism. Now, let the reader remember that we are not the parties that have raised this question of atheism. We neither affirmed atheism, nor insinuated it, nor implied it. We strictly avoided a mode of statement which

might be twisted into any such construction. It is the theological teachers, the editors of religious newspapers, that thrust the question forward; and they treat it in a way that will entitle them, in our opinion, to rank among the most efficient propagators of atheism. The Rev. Mr. Talmage is an authorized teacher of religion, and, as he is followed by multitudes, it is presumable that his statements have weight with them. He tells them that the AMERICAN CYCLOPÆDIA is a propagator of atheism, because it states in three lines the scientific principle that matter is indestructible. Atheism is here put as the necessary consequence of a demonstrated truth—rather suicidal theology, we should say—but who is the real propagator of atheism, he who simply states the truth, or he who construes it as atheistic? An established principle of science is taken up and subjected to a little theological fumbling, with the result—no God!—let the fumbler take the responsibility. We throw back this charge of propagating atheism where it belongs, upon those who seek every occasion to declare that the question of the existence of God is dependent upon what is going on in the field of scientific research. It was these religious teachers who affirmed that, if the earth is in motion, or was not created in six days, there is no God; and it is these who now say that if evolution, or spontaneous generation, or the doctrine of the correlation of physical and mental forces be true, there is an end to all religion; or, if matter is indestructible, atheism is the consequence—it is these that are sowing the seeds of doubt in the community, and doing more than any other parties to familiarize the general mind with the question of theism in its aspects of assumed uncertainty. We smile at the religious proceedings of the heathen who, after praying to his god for rain until he loses patience, takes him down and thrashes, kicks, and variously maltreats him for neglecting his duties. Yet, after all, how much worse is this than the habit of taking down the *idea* of God, and profanely battering it about like a foot-ball in the logical arena? We have preachers who make the pulpit a kind of conjurer's platform, where the conception of the Deity is manipulated by syllogistic legerdemain, appearing here and vanishing there, now under this hat, and now under that, to the due astonishment of all beholders. Of the pagan referred to, one thing must in justice be said, that, although he pummels his god with great irreverence, he never doubts him. Some of our own theologians, on the contrary, seem to be more possessed with the idea of doubt in regard to the existence of the Deity, than any thing else. They treat it as an open question, and are forever dwelling upon its contingencies, and showing how if this, that, or the other thing be true, then there is no God at all, and every thing like religion is given over to destruction. We are constantly told that there is an alarming spread of disbelief in these days; what else can be expected under such inculcations? Let it be accredited to its chief source—the audacity and folly of those who use science to unsettle faith by forever insisting upon their antagonism; for religion has no enemies so dangerous as those who insist upon staking its truth upon any conditions or results into which it is the legitimate business of Science to inquire.

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### *THE SOCIAL SCIENCE ASSOCIATION.*

THE American Social Science Association held its May session in New York, and its proceedings have been made familiar to the public through the newspapers. They were of an interesting character, embracing able papers and discussions on a wide range of topics—education, labor, civil service, finance, sanitary subjects, etc. The earnest consideration of these

questions, and the collection and diffusion of information concerning them, is, beyond doubt, a most useful work, and, in doing it, the Association should have the sympathy and God-speed of the community.

But, while recognizing that the aim of this organization is excellent, and much of its work highly commendable, we are of opinion that it falls short of what should be its chief duty. It fails to do that for which, judging by its title, it was specifically instituted. So far from promoting social science, we should rather say that social science is just the subject which it particularly avoids. It might rather be considered as a general reform convention. It is an organization for public action, and most of its members, hot with the impulses of philanthropy, are full of projects of social relief, amelioration, and improvement. Of pure investigation, or the strict and passionless study of society from a scientific point of view, we hear but very little. The President announced its leading object to be the promotion of the civil-service reform, and, if so, of course its leading object is not the determination of the natural laws by which society is constituted and regulated — that is, not scientific. If we remember rightly, at the establishment of the organization, the question, what Social Science is, became a matter of discussion, when the most extraordinary and conflicting views were propounded, and nobody seemed for a moment to suspect that social science is but a branch of general science, having similar objects, and to be pursued by the same methods, as the other sciences. Social science is a knowledge of the phenomena of society, as chemical science is a knowledge of the phenomena of the elemental changes of matter. And as the generalization of chemical facts gives us chemical laws, so the generalization of social facts must give us social laws. Social science is possible just to the degree in which these are arrived at. All the proceedings of the late meeting imply that there are such things as social laws, for, if there are not facts that can be known and compared, and effects that are traceable to causes, and an order of relations which makes it possible to calculate results, then the whole work of such an association is futile. Every project of social amendment which proposes that this thing shall be done rather than that, or that one course of action will result in evil, and another in good, presupposes facts, principles, and a method in the natural constitution of society which it is the legitimate province of science to investigate and determine. And, if this be so, it is obvious that the first and most imperative thing to be done is to trace these principles out, so as to arrive at a system of elementary truths that may be taken as the starting-point and foundation of all active measures of social improvement. The working out of something like a definite and authoritative basis of scientific principles, we say, is the first thing to be done, and this view is sustained by all that we know of the past history of science. All the arts were but blind, and arbitrary, and ineffectual processes, until the sciences upon which they depended were worked out in their fundamental principles as pure questions of research. Not until the laws of physics, chemistry, anatomy, and physiology, were determined by a long course of patient and assiduous observation and experiment, pursued with no reference to any thing but the simple establishment of the truth, did the various arts become settled in their practice, so that they could be pursued with efficiency, economy, and success. Much useful work was undoubtedly done while artisans were still blindly groping without rational guidance, cutting, and trying, and wasting power, time, and materials, in following empirical rules. And so, as we have already recognized, much

useful work is done by our social reformers; but, in our opinion, they are attempting to attain ends which, if attainable at all, are not to be reached until there is a far clearer understanding of their conditions, and of the principles by which the progress of society is controlled. The Association seems to be but little in advance of an ordinary political convention. Its teachers appear to start from the fundamental postulate of politics, that human society is the product of government, that its regulative laws are the result of majority votes, and consequently that legislation is to be invoked for every thing. There is little recognition of a sphere of natural activities, spontaneous, and self-adjusting, with which government can only meddle for disturbance and mischief; and, of course, there is no investigation of it. What things it is impossible to effect by political agencies, what had better be left to private enterprise, what is the effect of constant intermeddling, and what are the values and limits of those activities which belong to the natural constitution of society, are not among the primary subjects of inquiry. Yet a true social science must, first of all, throw light upon these questions, and, if its effect is to explode many fallacies—to show that the perpetual motions, the philosophers' stones, and the elixirs of life of social projectors, are only groundless fancies—the result must be accepted with never a doubt that, in place of the discredited crotchets, more rational and valuable devices will arise.

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### *THE PRINCIPLES OF SOCIOLOGY.*

The short article on climate and social development which we reprint from advance-sheets of the "Principles of Sociology," by Herbert Spencer, will be welcomed by many as showing the progress of his great work, and that he has at length fairly entered upon that important division of it which deals with the phenomena of society. The "Principles of Sociology," as they will constitute the largest division of his philosophical series, will probably be also its most important division. Mr. Spencer took up social subjects as matters of study in his youth. One of his first publications at the age of twenty-two was, his letters on the "Proper Sphere of Government," in which society was considered from the scientific point of view, or as having its natural laws of regulation and development. Eight years later he published "Social Statics," in which these ideas were expanded and extended, but the completion of this work only brought him fairly to the threshold of the subject. He saw that it must be treated in a far more systematic way, and after ten years of labor directed to a large number of social questions, and working out the principle of Evolution as applied to them, he began his philosophical system in 1860. Fourteen years of labor have brought him to the point from which he started thirty-two years ago, enriched in ideas by a long course of investigation preparatory to dealing with the sociological problems now before him. He begins the "Sociology" as he began the "Biology" and the "Psychology," with the consideration of its data. Those who have examined the "Descriptive Sociology" will remember that at the heads of the tables a class of facts is presented, concerning the various conditions of the country, physical and climatic, with its productions and resources, and the characters of its inhabitants, mental and emotional, by which the state of society is modified, and which of course vary greatly with different communities. After defining Sociology in the first chapter on "Super-Organic Evolution," in which the significance and value of the social instincts exhibited by insects and the lower animals are considered, Mr. Spencer passes in Chapter II. to "The Factors of Social Phenomena,"

and the subjects just referred to as presented in the tables are now entered upon. Chapter III. is devoted to the "Original External Factors of Social Evolution," and the extracts we now publish are a small part of this exposition. The same questions are touched upon here that Mr. Buckle took up in the early part of his introduction to the "History of Civilization," although it is hardly necessary to say that they are very differently treated.

It may be proper to call attention to one feature of the forthcoming work which will be of general interest. In the preceding volumes on "Biology" and "Psychology," Mr. Spencer has undoubtedly lost some reputation as a popular writer. Those who had read with interest and enthusiasm his brilliant essays, toiled hard over the Biological and Psychological discussions, and got the impression that Mr. Spencer had degenerated in his power of lucid and felicitous exposition. The difficulty, however, was not in the writer, but in the subjects, the facts with which he chiefly dealt being more or less scientific, technical, and foreign to general readers. Dealing with principles and relations, his statements were necessarily abstract, but the trouble was that the terms of the relations and the facts from which the principles were derived were unfamiliar to the common mind. But, in treating of Sociology, or the phenomena of society, Mr. Spencer again enters a sphere of thought the elements of which are no longer foreign to ordinary thought. The "Principles of Sociology" will discuss questions that are quite within the range of popular apprehension, and the difficulty, of which much complaint has formerly been made, will disappear. That Mr. Spencer is very far from having lost or impaired his power of familiar and telling statement we have lately had abundant proof in his series of articles on the "Study of Sociology," a work which is being now widely read and enjoyed by many who were at first under the impression that they would be unable to follow and understand him.

The "Principles of Sociology" will be published in quarterly parts, with regularity if Mr. Spencer's health allows. They will be sold at sixty cents a number, or furnished to regular subscribers at two dollars a year. That the information to be contained in this work will be of the highest value and importance we need scarcely say, and it may be strongly commended on this ground alone; but we appeal to our readers to patronize it, and to induce their friends also to do so, on the further ground that Mr. Spencer is engaged upon a great original and constructive enterprise, and ought to be so amply sustained that he shall suffer no impediment or annoyance of a pecuniary nature in prosecuting his work.

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### *WAR AND EDUCATION.*

One of the most striking results of the sudden rise of a military feeling throughout the country, during the civil war, was the influence it exerted upon education. One might have reasoned that if our educational system be, from top to bottom, that perfection of wisdom which many claim for it, it is the one thing that would have remained unaffected by the accidental circumstances of a war into which we drifted. But our system of education is as far as possible from being strongly knit and firmly organized, and as, on the other hand, it is loose and unsettled, it was very naturally affected by the prevalence of the military feeling. This was seen by the adoption of military exercises in a great number of schools, under the idea that they were to become part of the regular and permanent policy of instruction. And where these were not adopted there was still a new impulse in the way of marching, marshaling, and manœuvring the classes

and divisions of large schools; and as this was a showy demonstration it was very telling with the public, and was carried in some cases to ridiculous extremes. We once heard a thoughtful teacher remark, after observing a long course of these mechanical exercises, "I begin to think that one thing answers just as well as another for education." The encroachment of the military spirit was also visible in the reaction toward a severer discipline, a more decided advocacy of corporeal punishment, and the substitution of physical for moral forces as motives to conduct. In short, our schools were deeply and in various ways impressed by the new retrogressive spirit which carried away the country. But, as it came suddenly, it proves not to be lasting, and things are now beginning to resume their old course. The most striking indication of the disposition to return to the old order has been recently exhibited in Bowdoin College, at Brunswick, Maine. That institution, it seems, was turned into a kind of half-military establishment, field-drill being a regular exercise. So important was it regarded by Government, that a United States officer was sent there to take charge of this branch of the collegiate work. But the exercises became irksome, and such a bore to the students that, after long and unavailing protests, they at length revolted and almost unanimously refused to drill. The college authorities also refused to yield, and the conflict arrested the operations of the institution. It is a little case of revolution, and as revolution is the mother of war, the war-faculty of the college should not have condemned it too decisively. There seems to be a difference of opinion as to which party was right. The sticklers for discipline and authority of course go with the Faculty, and will no more tolerate the rebellion of the students than they would the mutiny of soldiers against their officers. On the other hand, it is maintained that the republican theory should be carried out in college as well as elsewhere; and that all civil government "derives its just powers from the consent of the governed." Whatever be the result, it cannot be denied that the students have taught the Faculty a wholesome lesson, which is, that they have rights that the authorities are bound to respect, and, if not respected, to be enforced by a resort to extreme measures, too frequently the only way in which rulers can be made to learn any thing.

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## LITERARY NOTICES.

TABULAR STATEMENTS, FROM 1840 TO 1870, OF THE AGRICULTURAL PRODUCTS OF THE STATES AND TERRITORIES OF THE UNITED STATES OF AMERICA. Classified by their Proximity to the Oceans and other Navigable Waters, Natural and Artificial. By SAMUEL B. RUGGLES, Member of the New York Chamber of Commerce. Fifty pages. Price, 50 cents. New York: D. Appleton & Co.

ALTHOUGH this publication takes the form of a pamphlet, and has been made cheap to facilitate its wide circulation, yet we warn our readers not to infer its importance from its form. Carbon is carbon, but an ounce of diamond will outweigh cargoes of coal in value; and so, while knowledge is knowledge, it is possible that a pamphlet may outweigh cart-loads of books in the intrinsic value of what it contains. Until we took up this monograph of Mr. Ruggles on the agricultural resources of the United States, we did not believe it possible to condense in a clear and classified form such a vast array of valuable facts as he has here presented in the compass of fifty pages. To present the resources of a continent, statical and dynamical, the distribution of the elements and the laws of their changes, so as to give us the data for the evolution of a great empire of industry, is an exploit that no man but Samuel B. Ruggles, with his life apprenticeship at the art and mystery of extracting wisdom from statistics, could have performed.

That agriculture is the foundation of

society, and necessarily of all that society contains and accomplishes, is a sufficiently commonplace statement, but it is one of the great facts which must never be overlooked. Agriculture not only furnishes the great mass of materials in the transformation and distribution of which numerous classes of society are occupied, but it furnishes the materials out of which human beings themselves are made. The dust of the earth, and the gases of the air, under the magical enchantment of the forces of the universe, are transformed into the substance of life, and the farmers are the superintending priests of the marvelous and mystical change. This continent is destined to feed and to clothe not only its own increasing millions of human beings, but other and numerous millions of people in distant parts of the earth. One of the first great problems, therefore, which press for solution in regard to the future of this country, is that of transportation for the distribution of products to which commercial exchanges give rise. Mr. Ruggles, hence, takes up the question first of all from the point of view of physical geography, or the construction of the continent, by which all possibilities of movement are primarily determined. His presentation of the resources of the country is not made in mere alphabetical order, as in the official census, but topographically by their proximity to oceans, rivers, lakes, and other facilities of transportation. In accordance with this idea, he cuts up the country into seven great districts, which embrace: I. The New England States; II. The Middle Atlantic States; III. The interior States north of the Ohio, and on the Upper Lakes and Upper Mississippi; IV. The Southern Atlantic States; V. The Southwestern States south of the Ohio and on the Gulf of Mexico; VI. The States on the Pacific and adjacent Territories; and VII. The Territories in and east of the Rocky Mountains.

All the products of agriculture in each of the States and Territories are given in detail, and the rates of increase are also presented by showing the amount of each at the end of the three decades closing with 1850, 1860, and 1870. The whole is then considered with reference to the racial diversities of our population, or by "nationalities." We are thus enabled to compare the different States and Territories, side by side, in reference to the amounts and rates of change of their total population, and the various classes of the population, the amount of land in cultivation, the cash value of farms, and its ratio of increase; the kind of products in each locality, and the profits that arise from them; the yearly product of farms, the agricultural capital per head, and average annual income per head of the Germans, Irish, English, Scotch, Swedes, and natives of the United States.

The agricultural population of the American Union was, in 1870, 5,922,741, and had created and acquired a property in agricultural wealth valued at $11,124,985,747, showing an average value of $1,878 per head, yielding a net yearly income of $360, or nearly $1 per day. Ten States, in 1870, produced more than 21,000,000 tons avoirdupois of cereals, and will probably produce, at the end of the century, 40,000,000 or 50,000,000 of tons annually.

These gross results are sufficiently impressive, but the value of Mr. Ruggles's statement is not in his striking array of aggregates, but in that marvelous analysis by which the discriminations are carried down to the utmost details, so as to bring out the conditions, chances, probabilities, and possibilities of individuals. The Frenchman, or the Dane, who wishes to emigrate to this country, by consulting this pamphlet, may inform himself of the condition of his own class of people, where they go, what they do, and how they have got on in the new country. And so any person in Europe, of special aptitudes and industry, desiring to emigrate, may learn where that particular kind of industry is most practised and most profitable.

But, while this pamphlet is of inestimable value from a practical point of view, and ought to be scattered by millions in Europe, it is no less interesting and important as a contribution of data to political philosophy. The highest form of science is quantitative. We must not only know the fact, but measure it, that is, know it exactly. Until this is done, principles cannot be deduced so as to serve for valuable guidance. Careful statistics are quantitative data for sound social reasoning.

Some say that they are dry, but in all such cases the aridity is subjective. Statistics are the intellectual representations in their most precise form of the phenomena and realities to which they apply. Mr. Ruggles's facts are the foundations of important truths, a report of the circumstances of a great people, a register of their advancement, and the basis of prophecy. His pamphlet is not suitable to be read at a tea-party, and cannot be set to music; but, as Mr. Emerson says that the most important part of education is its *provocative* element, this little digest answers to that character; it is a provocation to endless thought on important questions, and, as such, it may be a valuable help to the education of the American people.

HIGHER SCHOOLS AND UNIVERSITIES IN GERMANY. By MATTHEW ARNOLD, D. C. L. London: Macmillan & Co. 12mo, 270 pp. Price, $2.00.

MR. ARNOLD was, in 1865, charged by the School Inquiry Commission of Great Britain with the work of investigating the system of education for the middle and upper classes of the principal nations on the Continent. In 1868 he published a volume on "Schools and Universities on the Continent," giving the results of his investigation. The present volume is a reproduction in separate form of that part of the original book which related to the German educational system. The Prussian system is taken as an example of what existed throughout Germany. The higher schools of Prussia are gymnasiums and real-schools. There are subordinate branches of each of these, known respectively as progymnasiums and upper burgher schools. They are essentially the same as the former, with the omission of one or more of the higher classes. Gymnasiums lead to the universities, and therefore afford professional training, while real-schools, leading only to business, present a practical course of studies intended to fit the pupil for the ordinary affairs of life. Sometimes the gymnasium has a department corresponding to the real-school, for the advantage of pupils displaying a peculiar fitness for that class of studies. The gymnasium is the stepping-stone to the university. The certificate of having passed the "leaving examination" of the former is an indispensable card of admission into the latter. The gymnasium and real-school have each six classes. Twenty-eight hours for the lower classes, and thirty for the higher, is the required time, per week, for school-work in the gymnasium. This is distributed among the different studies in varying proportions: Latin gets the most—ten hours—natural sciences get two hours in the highest class, and one in the next; religion gets two hours in the four higher classes, and three hours in the two lower ones. The scholastic term constitutes nine years—one year each for the three lower classes, and two each for the higher. The universities have four faculties each—theology, law, medicine, and philosophy. Philosophy embraces the humanities, or languages and their literatures, the mathematical and the natural sciences. Some universities have a distinct faculty for political economy, others embrace it under the general head of philosophy. All schools, both public and private, are under the control of the state. No one wanting the proper qualifications for a teacher is allowed to set up a private school. Private schools of the higher kind are also discouraged, by the fact that a pupil cannot enter a university without having passed the "leaving examination" of the gymnasium. As is well known, school attendance or efficient private instruction is compulsory on the children of all classes. Catholic schools are maintained for Catholic children, and Protestant for Protestants. A small number of either sect attending a school of the opposite persuasion are not compelled to receive the established religious instruction, but may be provided with instruction of their own sect, at the expense of their parents. In schools where the number of Protestants and Catholics is very nearly equal, an instructor for each sect is appointed. For the government of the schools, the state is divided into eight provinces, and subdivided into twenty-six districts. Each province has a school-board composed of a president and a director, with two or three other members, who are usually a Protestant, a Catholic, and a person practically versed in school matters. Each district has also a school-board constructed

on the same principles as the provincial board. The latter govern the higher schools of first grade, and the former those of the second grade, and the primary schools. All of these boards are under the control of an educational minister located at Berlin, with whom they are in continual communication, and to whom they make a general report on school affairs once in every two or three years. There are also seven examination commissions whose business it is to examine applicants for the positions of teachers. The Minister of Education appoints the professors of a university, from names suggested to him by the academical senate. The full professors elect a rector, or, in cases where the king is titular rector, a pro-rector, to serve for one year, and an academical senate, also for one year. The senate consists of the actual rector, the retiring rector, and a full professor of each faculty. Besides the full professors, is a class of assistant professors, and another class called *privatdocent*, which stands partly in the capacity of private tutor and partly as an *attaché* of the university.

KRÜSI'S DRAWING. By HERMANN KRÜSI, A. M. New York: D. Appleton & Co.

THE art of Drawing and the art of thinking are based alike upon two simple principles. The crude leaf-picture of the novice and the accurate landscape of the experienced draughtsman are the results of one and the same process—the combination of *straight* and *curved* lines. The only difference between them lies in the degree of skill with which the lines are combined. The infant, recognizing its mother, displays the same mental process that Newton employed to produce his "Principia." The child recognizes its mother by perceiving her *unlikeness* to the other persons around her. Newton discovered the law of gravitation by detecting the *likeness* displayed in the movements of falling bodies. The art of thinking, in its rudest as well as its most perfect state, is simply the *detection of likenesses and unlikenesses* displayed in things. The only rational method, therefore, of cultivating the art of thinking—in other words, of education—is to teach the mind to seek for and trace out those likenesses and unlikenesses. To cultivate the art of Drawing, the pupil is taught to distinguish between straight and curved lines, between the effect produced by drawing a straight line in one direction, and that produced by drawing it in another; and further, to distinguish between the effects of combining both kinds of lines in various ways. To draw a leaf, a flower, or a house, he must first recognize the differences in the various major parts and minor parts, and then the difference in the character and direction of the lines required to represent those parts. But that is learning to discriminate between different things and different parts of the same thing, is learning to recognize likenesses and unlikenesses—is learning to think. The child who maps off in his mind the various like and unlike parts of a leaf or a flower with a view to reproducing them on the paper before him, is learning to think in botany, and soon begins to classify leaves, flowers, plants, and trees, according to their peculiarities of form and structure. He that observes the differences and similarities in the various parts of an insect or an animal, for the purpose of making a drawing of that insect or animal, is learning his first lessons in zoology. And he that is able to represent the different forms and structures of rocks and minerals has learned his first lessons in geology and mineralogy. In short, there is scarcely a science that cannot be taught, well taught, and agreeably taught, by the aid of Drawing. For, in teaching a pupil to draw, you cultivate his observation, quicken his perception, and strengthen his judgment. He forms a habit of scrutinizing objects with a view to discerning their component parts, which is an act of observation; of separating the like and unlike parts from each other, and these again into their respective smaller parts, which is an act of perception; and, in comparing the features of the parts with each other for the purpose of ascertaining their likeness or unlikeness, he performs an act of judgment. Thus drawing awakens and develops the three most important faculties of the mind; upon them rests the whole fabric of Thought. By observation of things, we perceive their differences from some things and likeness to others, and we judge or classify them accordingly; and from observation of things

we step naturally and certainly to the observation, perception, and classification, of principles which constitute the highest exercise of thought. Drawing, therefore, should be cultivated primarily as a means of developing the mind; secondarily, as an accomplishment or a profession. Instruction in it should begin in early childhood, and continue until education is accomplished; and, instead of being given to a few, it should be given to all.

The work before us appears preëminently adapted to produce natural and rational mental development. The pupil has his attention directed first to straight lines, and, being shown the difference between horizontal, perpendicular, and oblique, he is required to invent forms that can be represented by the combination of two lines. In order to give direction to his efforts, he is furnished with a book containing representations of a few such combinations, but he is not allowed to confine himself to the imitation of these; he is taught to observe in things around him suggestions for other forms. In like manner he is taught to combine three, four, and as many as eight lines. Next, he is led through the same process in the combination of two or more right, acute, and obtuse angles, squares, oblongs, rhombs, etc. Being thoroughly versed in rectilinear forms, he is introduced to curved lines, circles, etc., and taught to combine them in the same manner that he followed with straight lines. As the pupil is herein taught to construct forms from simple lines, it is called the Synthetic Series. And, in order to give the development of his mind a scientific turn, the examples given in the various combinations lead with straight lines to the construction of crystalline forms, and with curved lines to the simpler vegetable and animal forms.

The Analytic Series, which is the next above, begins like the other, with straight lines, the difference being that, instead of constructing forms as in that case, the pupil is here required to pull them to pieces. He is first shown how to bisect and trisect a single line, and then to treat similarly the various sections thus formed. He is next given a square, and required to form designs on the bisection of it; next, on the trisection, and so on, until he becomes perfectly familiar with the innumerable forms that can be produced on the basis of a square, an octagon, or a hexagon. And he is led to observe on which of these bases the objects around him can be represented. He is instructed in the same manner with regard to the circles and ellipses. Thus, by an easy and interesting process, the pupil is brought to perceive and understand what is indispensable alike to drawing and to scientific thinking, the relation of parts to the whole. The examples in this series lead to landscape-gardening, architecture, and descriptive anatomy.

A Perspective and Geometric Series, based on the same plan as the two published series, will follow, to complete the system.

THE DOCTRINE OF EVOLUTION: Its Data, its Principles, its Speculations, and its Theistic Bearings. By ALEXANDER WINCHELL, LL. D. 148 pages. Price, $1. Harper & Bros.

WITHIN the compass of this little volume, Chancellor Winchell has summed up with great fairness, although, of course, with brevity, the leading arguments that are offered both for and against the theory of evolution. He has certainly not failed to do justice to its objectors; and his book is especially valuable as presenting very fully certain arguments against Darwinism that are not readily accessible. As to his own position upon the subject he says: "Should the reader demand categorically whether the author holds to the doctrine of evolution or not, he replies that this seems clearly the law of universal intelligence under which complex results are brought into existence. The existence and universality of a law operating upon materials so various, and under circumstances so diverse, but always evolving a succession of terms having the same values relatively to each other, is a fact which, to the ear of reason, proclaims intelligence more loudly than any possible array of isolated phenomena. But the diversity of the materials with which the law has to deal, brings out a variety of special values for the general terms of the evolutionary series. Mechanical force acts with uniformity, symmetry, and always in one

direction, producing results congeric with itself; hence, in the world of mechanical force, the series are complete, calculable, and demonstrative. But, obviously, other modes of activity are possible and probable to intelligent will. When acting in the organic instead of the mechanical world, though conforming still to a fundamental law of evolution, its results may *not* present series which shall be complete, calculable, and demonstrative, but incomplete, contingent, and suggestive. Such seems to be the character of the succession of animals and plants. The series, as an evolution, lacks its first terms; it presents regressions; it yields to the demands of physical correlations and ideal concepts; it betrays everywhere the activity of a force whose law is *not* that which dominates in the mechanical world.

"Mr. Spencer, in stating, in substance, that the efficient cause of evolution is a mode of the Unknowable, expresses our idea exactly in relegating this effect to a Power without the sphere of sensible things. But we differ from Mr. Spencer, *toto cœlo*, in respect to his dogma of the Unknowable, holding that the *causa causarum* is revealed qualitatively to every rational being. The cause of evolution is therefore a mode or volition of the incomprehensible Mind."

Dr. Winchell's book will well repay perusal to those who are interested in the literature of the subject; and the addition of Barrande's argument against Darwinism, in the Appendix, will augment its value to scientific students.

FIELD ORNITHOLOGY: Comprising a Manual of Instruction for procuring, preparing, and preserving Birds, and a Check List of North American Birds. By Dr. ELLIOT COUES. Salem Naturalist Agency, 1874. Price $2.50.

THE present work is a supplement to Dr. Coues's admirable treatise entitled "Key to North American Birds," published in 1872, and contains matter originally intended for that volume, but which, owing to lack of space, was left for future publication. The first half of the book consists of eight chapters, in which the reader is told in an easy, entertaining way how to proceed in the collection, preparation, and preservation of birds. As you must "first catch your hare," the author very appropriately devotes the opening chapter to the subject of implements of capture, and, the gun being the chief of these, minute directions for guidance in its selection, care, and use, are given. A short chapter on the employment of the dog as an aid in collecting comes next; and is followed in Chapter III. with directions for general field-work, such as the time of year to make collections, the manner of approaching birds, their recovery after being wounded or killed, and how to dispose them for carriage homeward. The last section of this chapter, on "The Hygiene of Collectorship," contains a good many valuable suggestions that apply with equal force outside the business of bird-collecting. The fourth chapter deals with the subject of notes and labeling; the fifth is on instruments, materials, and fixtures, for preparing bird-skins; the sixth contains directions for skinning, and the preparation of skins; and the seventh treats of miscellaneous matters, such as the determination of sex and age, the study of osteological characters, and the collection and preservation of eggs and nests. The last chapter is on the care of a collection, and gives directions for the construction of cabinets, and the exclusion of insect pests. Drawn from the writer's own experience, which has been most varied and extensive, these instructions cannot fail to be of great use to those proposing the study of birds at first hand.

The second part of the book consists of a check-list of North American birds, intended to replace the one now in use, which, owing to the rapid advance of the science of ornithology, has become defective in many ways. A notable feature of the new list is the reduction of the number of genera, and especially of the number of species given in the old one, in accordance with the growing conviction that naturalists long ago got ahead of Nature in the formation of specific distinctions.

PROCEEDINGS OF THE GEORGIA TEACHERS' ASSOCIATION.

IT is an encouraging sign to the friends of progress that school-teachers are awakening to the necessity of scientific education. At the seventh annual meeting of

the Association, whose report we have before us, held at Atlanta, Georgia, April, 1873, Mr. W. Leconte Stevens, of the Boys' High School of Savannah, delivered an address on "Scientific School Studies," which has in it the ring of the true metal. Scientific education is justly prized, not only for the practical knowledge that it imparts, but also for the discipline it affords to the mind in drawing out and strengthening the perceptive faculties, and inducing clear and accurate habits of thought.

THE GREAT ICE AGE AND ITS RELATION TO THE ANTIQUITY OF MAN. By JAMES GEIKIE, F. R. S. E., etc. New York: D. Appleton & Co. 8vo., 525 pp. Price $2.50.

THERE are many persons who would listen with an air of scornful incredulity to the statement that the hills and valleys of New York and New England, which summer now clothes with a mantle of luxuriant verdure, were once a dreary, desolate waste, covered up by a crust of ice many hundred feet thick. Nevertheless, the fact is indisputable; the mountains, the rocks, the configuration of the soil, even the fragmentary stones that lie upon the surface, point silently, eloquently, and immovably, to the fact. Geologists had long noticed, in valleys adjoining mountainous districts, certain long, low ridges, called "sow-backs," running parallel to each other and trending down the valley. They had dug into these ridges and picked out flat, oblong stones, with strange scratches upon their surfaces. They had noticed that, while the mountain-sides looked jagged and rugged from below, from above they presented a rounded and undulating outline to the very base of the mountain. It was also noticed that the rocks on the mountain-sides displayed on their undulating or upper surface the same mysterious scratches or striæ that were observed on the stones embedded in the ridges below. All of these signs greatly puzzled the geologists, and various theories were invented to account for them, but their true significance was not dreamed of until the late Prof. Agassiz, from the study of Alpine geology, announced that they were the results of one and the same cause—glacial action; that is, that the whole face of the country was covered to the depth of two or three thousand feet with solid ice, which, in gradually creeping toward the ocean to shed its bergs, had worn the mountain-sides into waves; broken, scratched, and transported the rock to distant points, and furrowed up the soil of the valleys through which it continued to crawl seaward. Unmistakable evidence existed that this arctic condition of climate prevailed all over Europe, Asia, and America, northward of 45° north latitude; that is to say, that the vast area comprehended within that circle was once covered with ice as completely as parts of Greenland and the rest of the country immediately around the north-pole is now covered. Of course no life could exist under such conditions, and it was therefore supposed that the advent of man, within that circle at least, must have occurred subsequent to their passing away. It is on this point that Mr. Geikie's book throws a flood of light. He describes the evidences of the glacial condition with admirable skill and clearness, and then proceeds to consider its bearing on the antiquity of man. The earth and stones, or "rubbish," that covers the rocky foundation of the countries comprehended in the circle described, is called the "Drift or Glacial Formation," to indicate that it was deposited thereon by glacial action. The drift is divided into two parts, the upper drift and the lower drift. The lower is, of course, the oldest formation. It is composed of a "tough, stony clay," colored like the rocks about which it lies, and small, fragmentary stones, flattened and scratched. The mass of clay and stones is called "till." The till is not laminated, but pressed down in a confused mass, and its coloring shows it to have been produced by comminution of the rock upon which it lies, while the rock itself corroborates that testimony by being scratched and polished like the stones in the till. Thus the till was formed by the grinding of the ice against the rock. Deeply embedded within the till, occur at intervals deposits of sand and gravel, such as we find at the bottom of lakes and rivers. But how could there be lakes and rivers to deposit sediment, while the whole country was covered by a crust of ice more than a thousand feet thick? This is a question that has long puzzled geologists. But only because

the true significance of these sand and gravel deposits was not before seen. Mr. Geikie has pointed out that the deposits occurred during an intermission of the Great Ice Age, when the ice melted and disappeared from the land, which became clothed, instead, with trees and plants, and peopled with animal forms. In the course of ages the arctic conditions returned and covered the land again with ice. He has also pointed out that this alternation of temperate and arctic climate has certainly occurred more than once, probably several times. Mr. Geikie's inference becomes still stronger when viewed in the light of Mr. Croll's new theory of a periodic change of climate resulting from the precession of the equinoxes and the increase of eccentricity in the earth's orbit. We have no room for an explanation of Mr. Croll's theory, but must content ourselves with referring the reader to Mr. Geikie's book, where he will find it lucidly stated.

Now, these facts have a very important bearing on the history of man. The remains that we have gathered of primitive man are divided into *paleolithic*, or those belonging to the Old Stone Period, and *neolithic*, or these belonging to the New Stone Period. The *paleolithic* remains are characterized by the rudest kind of stone implements, implements merely chipped out of stone, without any attempt at finish, and from first to last there is no evidence of improvement in their make. The *neolithic* implements, on the other hand, are much better made at the starting-point, and they gradually improve, until they give place to implements of bronze. Again, the *paleolithic* remains are accompanied with the remains of mammalia, such as the mammoth, etc., which are now wholly or locally extinct, while the mammalian remains found with those of *neolithic* man are of existing species. Lastly, the *paleolithic* remains are found in the deposits of sand and gravel we have described as imbedded within the till, while the *neolithic* remains are found only in the upper drift. Thus in one and the same way the existence of man is shown to extend to inter-glacial, probably to pre-glacial times, and the meaning of the apparent gap in his history between the *paleolithic* and *neolithic* ages is explained. The *paleolithic*, or interglacial, perhaps pre-glacial man, was driven from the country, or destroyed by the change from a mild to an arctic climate; and, when the arctic conditions passed away for the last time, his place was filled by the *neolithic*, or post-glacial man, from more southern latitudes. We have indicated in a necessarily general manner the central idea of Mr. Geikie's book; it contains a great deal of very interesting information of a subordinate character, which will amply repay perusal.

MY VISIT TO THE SUN; OR, CRITICAL ESSAYS ON PHYSICS, METAPHYSICS, AND ETHICS. By LAWRENCE S. BENSON, author of "Benson's Geometry." New York: James S. Burnton. 8vo, 157 pp. Price, $1.50.

IF we were called upon to state the object for which this book was written, we should say that it was to display what the author evidently fancies to be a very wide and accurate knowledge of science. With all the flourish and clatter of a Don Quixote charging the windmill, he impinges the mighty lance of querulousness against the feeble form of gravitation, utterly annihilating that venerable body. The atomic theory in chemistry, and the Fayian and Franklinian theories in electricity share the same fate, as do many kindred absurdities long fostered by the ignorance of man. And, as if those blows did not inflict punishment enough on the physicists, they are utterly crushed by the entirely new and astonishing revelation that final causes are unknowable. The present volume is on physics, and the most appalling fact that it contains is the announcement that it is to be followed by similar volumes on metaphysics, ethics, etc.

THE PRINCIPLES OF SCIENCE: A Treatise on Logic and Scientific Method. By Prof. JEVONS. Macmillan. Price, $5.00.

WE recently noticed this important and valuable work, and we now again refer to it simply to inform such of our readers as may be interested, that the publishers have issued a special American edition (in one volume) at a reduced price, which will make it more accessible to that large class of students to whom it makes a serious difference whether the price of a book is nine dollars or five dollars.

# MISCELLANY.

**Volcanic Eruption in the Sandwich Islands.**—A correspondent of the *American Journal of Science* writes that, until the past year, the great summit crater of Mauna Loa (Sandwich Islands) has for a number of years shown but few and feeble symptoms of activity. For a few days in August, 1872, there was a brilliant light in the crater, and again on the 6th and 7th of January, 1873, there were vivid demonstrations, which roused the attention of many witnesses. But it was not until the 20th of April, 1873, that a continuous exhibition of mountain pyrotechnics commenced. From that day down to the date of the letter (January 6, 1874), the action within the great caldron was incessant. Most of the time the boiling was vehement. "The scene was never more brilliant than a few nights ago. Sustained jets of molten rock were constantly rising 50 to 200 feet within the mural caldron, and the surgings, puffings, and roarings, have been heard low down the sides of the mountain, and, as some testify, as far as Reed's Ranch, probably fifteen miles." The most distinguishing feature of this eruption, however, was its duration. The eruption of 1855–'56 flowed fifteen months; but this rent the mountain laterally, and flowed longitudinally; whereas the present eruption has made no lateral vent, and found no outlet, so far as known. During all this time Kilauea was unequally active. The great depression of Kilauea, caused by the eruption of 1868, is fast filling up by repeated overflows from the south lake, while all around that lake a vast mound is rising, whose summit is nearly as high as the southern rim of Kilauea, and it may soon overlook it.

**Need of a New Chronology.**—From the presence of the Egyptian Pyramids, Bayard Taylor thus writes to the *New York Tribune:* "As I rested in the shade, looking up to the gray pinnacles, so foreshortened by nearness that much of their actual height was lost, yet still indescribably huge, I could think of but one thing: we must have a new Chronology of Man. There, before me, the Usher-Mosaic reckoning was not only antedated, but a previous growth, of long, uncertain duration, was made evident. There, in stones scattered about the Desert, were inscriptions cut long before any tradition of Hebrew, Sanscrit, Phœnician, or Greek—clear, intelligible words, almost as legible to modern scholarship as those of living languages. This one long, unbroken stream of light into the remote Past lights up darker historic apparitions on all sides, and sweeps us, with or without our will, to a new and wonderful backward starting-point. Of course, the learned in all countries are familiar with all our recently-acquired knowledge on this point; but is it not time to make it the property of the people everywhere—to discard the unmanly fear that one form of truth can ever harm any other form—to reveal anew, through the grandeur of Man's slow development, the unspeakable grandeur of the Divine Soul by which it is directed?"

**Life in an Attenuated Atmosphere.**—M. Paul Bert, in a communication to the French Academy, details some further experiments made on himself, with reference to the effect of changes of barometric pressure on life. He entered his large apparatus of decompression, and the pressure was brought down to 450 millimetres (somewhat less than 18 inches of mercury); it was then maintained between this and 408 millimetres (16½ inches) for a little over an hour. These pressures correspond to heights of 13,448 and 16,728 feet. At 450 millimetres the author began to experience "mountain sickness"—a feeling of heaviness and weakness, nausea, fatigue of sight, general indifference, and laziness. Having lifted his right leg, it was thrown into convulsive trembling, which extended to the left, and lasted some minutes. The face was somewhat congested, and the temperature under the tongue increased. He also remarks that he was unable to whistle. The important point of these experiments, however, was this: he had taken with him a small vessel full of oxygen, and, when the pressure had reached 430 millimetres, he inhaled some of it. His pulse, which had risen from 62 to 84, immediately fell to 71,

and the mountain-sickness for a time disappeared. Immediately on inhaling the oxygen there was a disagreeable dazzling, and at one time, after three inspirations, he became giddy and fell off his chair, but soon recovered. The author also describes the effects on himself of breathing a superoxygenated mixture. With a mixture of 45 per cent., he could bear without injury a pressure of only 338 millimetres, which corresponds to the height of Chimborazo; and with 63 per cent. he was able to stand 250 millimetres (less than ten inches), and would have gone farther if his machine had been sufficiently strong. Since M. Bert's experiments, Messrs. Croce-Spinelli and Sivel have made a balloon-ascension to the extraordinary height of about 26,000 feet. They carried up with them a supply of oxygen, and, by using this after the manner indicated by M. Bert, they were enabled to live without inconvenience in an atmosphere of extreme rarity.

**Lake Superior Gold-Mines.**—Mr. Peter McKellar lately read, at the Toronto Institute, a paper on the gold-mines of Lake Superior. Some Indians from the vicinity of Thunder Bay, in 1871, brought to Mr. McKellar, at Fort William, several specimens of quartz, from an examination of which he was led to think that valuable gold-mines existed in the locality. The paper then described the lodes that had been discovered. The first was the Jackfish Lake lode, which lies about eighty miles west of Thunder Bay. From this lode 126 pounds of ore were sent to the Wyandott Smelting-Works, and yielded at the rate of $500 per ton; of this sum, $40 was derived from silver, and the remainder from gold. The Partridge Lake lode, lying about 100 miles northwest of Thunder Bay, yielded about $80 per ton of ore. In the summer of 1872 another lode, called the Heron Bay lode, was discovered, about 150 miles northeast of Fort William. It was similar to the Jackfish Lake lode, excepting that its yield of gold and silver was not so great. Mr. McKellar holds that these mines might be worked very economically, and that they would yield as large profit as, if not larger than, any others in the world. In the lodes already discovered, the gold was found very evenly distributed through the ore, which is said to exist in large quantities. Iron, lead, and other metals, occur in the neighborhood. The difficulties in developing these mines have been very great, owing principally to the unsettled state of the country. The Indians have refused to help in working the mines until some settlement shall be come to with them, as they fear that white men may come and dispossess them.

**Researches on the Zodiacal Light.**—Prof. Arthur W. Wright, of Yale College, who for upward of a year has been closely investigating the zodiacal light, has, by means of an apparatus of his own contriving, succeeded in demonstrating that this light is polarized. In the *American Journal of Science*, for May, Prof. Wright describes his polariscope, and the results at which he has arrived in the course of his researches. He finds that the plane of polarization of the zodiacal light passes through the sun. In no instance, when the sky was clear enough to render the bands visible, did their position, as determined by the observations, fail to agree with what would be required by polarization in a plane through the sun; not the slightest trace of bands was ever seen when the instrument was directed to other portions of the sky.

Having thus determined the fact of polarization, the next step was to ascertain what percentage of the light is polarized. For this purpose, the author again had to devise novel apparatus. The amount of polarization was determined to be, "with a high degree of probability, as much as 15 per cent., but can hardly be as much as 20 per cent."

The fact of polarization implies that the light is reflected, either wholly or in part, and is thus derived originally from the sun. The spectrum of the zodiacal light is not perceptibly different from that of sunlight, except in intensity. The author adds: "A particular object in these observations was to determine whether any bright lines or bands were present in the spectrum, or whether there is any connection between the zodiacal light and the polar aurora." The results give a decidedly negative answer to this question. "This is important

here," says the author, "as excluding from the possible causes of the light the luminosity of gaseous matter, either spontaneous, or due to electrical discharge. The supposition that the light is reflected from masses of gas, or from globules of precipitated vapor, is not to be entertained, since, as Zöllner has shown, such globules in otherwise empty space must evaporate completely, and a gaseous mass would expand until its density became far too small to exert any visible effect upon the rays of light."

From this it follows that the light must be reflected from matter in the solid state, that is, from innumerable small bodies (meteoroids) revolving about the sun in orbits crowded together toward the ecliptic.

**The Great Lava-Flood of the West.**—Prof. Joseph Le Conte, of the University of California, visited, during the summer of 1873, the central and eastern portions of Oregon, a vast lava-covered region, and published the results of his observations in the *American Journal of Science* for March and April, 1874. Using the word *lava* as synonymous with eruptive rocks, he says that between 200,000 and 300,000 square miles of surface is one field of lava. It is probably the most extraordinary lava-flood in the world. Commencing in Middle California as separate streams, in Northern California it becomes a flood flowing over and completely mantling the smaller inequalities, and flowing around the greater inequalities of surface; while in Northern Oregon and Washington it becomes an absolutely universal flood, beneath which the whole original face of the country, with its hills and dales, mountains and valleys, lies buried several thousand feet. It covers the greater portion of Northern California and Northwestern Nevada, nearly the whole of Oregon, Washington, and Idaho, and runs far into Montana on the east, and British Columbia on the north.

This enormous mass of matter evidently arose through fissures, and flowed until the streams or masses met, forming an almost continuous sheet. The Cascade Range of mountains seems to have been a source of immense overflow.

The area covered by this overflow cannot be less, says Prof. Le Conte, than 100,000 square miles, with an average thickness of about 2,000 feet, but having a thickness in some places of 3,700 feet. The statement, which seems an extraordinary one, is sustained by the extensive observations of Prof. Le Conte. The Columbia River cuts through the Cascade Range in a gorge a hundred miles in length, with perpendicular cliffs. The cascades of the river are at the axis of the range, and the cliffs here are 2,500 to 3,800 feet above the river-surface, and are composed of lava, tier upon tier, from top to bottom. Considering surface erosion, 4,000 feet is regarded as a moderate estimate for the original thickness of the lava-flood at this place.

But the entire thickness of the lava has been cut through, and the surface revealed on which the flood was originally formed. Here, at the river's surface, underlying the mountains of lava, are remains of ancient forests, and evidences of interesting geological changes.

There occurs at the river's edge, and about fifteen feet upward, a layer of coarse conglomerate; on this, a layer which appears to have been a dirt-bed, or old-ground surface. On this surface were found two silicified stumps, with their roots spread out, one of which was two feet in diameter, the roots reaching over an area twenty feet in diameter. Trunks of other trees were seen. Over this was a layer of stratified sandstone, with beautiful impressions of leaves of several kinds of forest-trees. Upon this lies about 100 feet of conglomerate, resembling drift, in the bottom of which were found trunks and branches of oaks and conifers. Upon the conglomerate the lava lies in columnar masses to a height of 3,300 feet.

The geological age of the wood and leaf-bearing stratum is believed to be miocene, or middle tertiary, and, if so, the lava-flood began to occur during or after the miocene.

**Why Paints crack and peel.**—A writer in *The Hub* thinks that the cause of paint cracking and peeling is to be found in the water which is contained in linseed-oil, as it comes from the hands of the manufacturer. He made the experiment of boiling linseed-oil by the heat of steam, until all

the moisture was expelled from it. On using this oil, without any drier, it was found to dry in one-half the usual time. He then mixed with it some siccohast, using only half the usual quantity employed to dry oil not boiled, and obtained similar results. "The introduction," says he, "of steam into the linseed before grinding aids in the expulsion of the oil; but it must stand a long time to precipitate the water completely. Boiling oil by steam does not change its complexion, save that it renders it clearer, and less liable to turn yellow with white pigments."

**Results of the Polaris Voyage.**—The following is from Dr. Bessel's memoranda of the discoveries of the expedition:

1. The Polaris reached 82° 16′ north, a higher latitude than has been attained by any other ship. Captain Buddington's testimony is very definite as to the impracticability of pushing a vessel farther north than the point which they reached.

2. The navigability of Kennedy Channel has been proved beyond a doubt.

3. Upward of 700 miles of coast-line have been discovered and surveyed.

4. The insularity of Greenland has been proved.

5. Numerous observations have been made relating to astronomy, magnetism, force of gravity, ocean physics, meteorology, zoology, ethnology, botany, and geology, the records of which were kept in accordance with the instructions supplied by the National Academy. A ninety-fathom sounding along the coast of Grinnelll-and brought up a highly-interesting organism of lower type than the *Bathybius* discovered by the English Dredging Expedition. It was named *Protobathybius Robesonii*. The natural-history collections were nearly all lost. They consisted of mammals, nine species of fur-bearing seals; birds, twenty-one species; insects, about fifteen species, viz., one beetle, four butterflies, six diptera, one bumble-bee, and several ichneumon-flies; also two species of spiders, and several mites.

It was found that the land was rising. Garnets of unusual size were found in latitude 80° 30′, having marked mineralogical characteristics by which the identity of some garnets from Fiskenaes was established. From such observations it became evident that the drift, which abounded on the land, runs from south to north.

**Australian Compliment to American Microscopes.**—But a short time ago, a small number of microscopists met in Melbourne, and decided to form an organization under the name "Microscopical Society of Victoria, New South Wales." The first general meeting of the Society was held in the Royal Society's Hall, October 10, 1873. About forty gentlemen were present, and a good exhibition of instruments and work was made. The president, Mr. W. H. Archer, read an address, from which we extract the following significant passage. Geologically, it is the oldest continent speaking to one the next in age; although politically it is the most recent of the peoples, speaking of science among one but a little older than themselves:

"One of the most interesting and practically useful objects for occasional investigation and discussion at our meetings will be the accurate determination of the real value to working microscopists of the various stands, objectives, and accessory apparatus so prodigally developed by makers in the mother-country. But, indeed, we should not confine ourselves to the results of English industry. Hartnack, of Paris, appears to be leading the way on the Continent to greatly-improved optical work; and Tolles, Spencer, and Wales, are said to be doing marvels in America. I hope to see the day when we shall have choice proofs of what the whole microscopical world can produce collected around us, and carefully tested by our own eyes and hands, in our own hall in Melbourne. One other thing, gentlemen, you as well as I should be rejoiced to see, and that is a really useful microscope of Victorian manufacture. At present, the idea is naturally provocative of a smile, but I cling to the belief that not only among the adult immigrant population, but even among our native-born youth, we shall some day find thorough mechanicians, who will emulate the marvelous skill and persistent energy of their forefathers. Look at the triumphs of the American microscope-makers. Their conquests are literally but of yesterday and of to-day. A generation ago

microscopes were a rarity in America. In the year 1840, when the United States Exploring Expedition to the South Seas, under Commander Wilkes, was fitting out, it was thought necessary to have a microscope. The various makers of scientific and philosophic instruments were applied to, but none of them could furnish the expedition with the thing desired. In this dilemma a private individual was appealed to, and an instrument thus finally obtained, in the shape of an inferior French microscope. How, then, did the present flourishing state of affairs come about? Simply by the genius of a self-taught man. He was a backwoodsman, and had pored over an old cyclopædia, and turned the optical knowledge contained therein, as far as in him lay, to sound practical account. At the age of twelve years he made his first lens. One day he happened to be shown a microscope constructed by Chevalier, of Paris, and the thought struck him that he would try to make a similar instrument. He succeeded, and his glasses were able to resolve a test which similar objectives of the first English opticians had hitherto failed to define. His name was Charles Spencer. And now his pupil Tolles, and Wales, a pupil of Smith and Beck, with Gronow, Zentmayer, and others, form a galaxy of American mathematical instrument talent that appears from recent accounts to be holding its own against the whole of the world. Is there not here a ground for the hope I expressed a little while ago? Surely after this example of Spencer, the young backwoodsman, many here present may live to see the day when a finished microscope shall be presented to their delighted gaze by the hands of an Australian townsman, at least, if not by an Australian bushman."

**The Improvement of Human Life.**—An extremely valuable paper by Dr. Edward Jarvis, on "Political Economy of Health," published in the Fifth Annual Report of the Massachusetts Board of Health, groups together very strikingly the vital statistics of various countries, to show the effect of the advance of civilization in protracting the term of human life. By better adaptation of means, circumstances, and habits, says Dr. Jarvis, man's life has been expanded, his strength increased, and his days on earth prolonged. By the improvements in agriculture and in vegetable and animal life, he has obtained better and more constant food, and is therefore better nourished. By the improvements in the arts he is better clothed and housed, better protected from the elements. The progress of civilization is best manifested in the progress of vitality. There is less sickness, and that which visits humanity is less destructive than in former ages.

In ancient Rome, in the period 200 to 500 years after the Christian era, the average duration of life in the most favored class was 30 years. In the present century the average longevity of persons of the same class is 50 years. In the sixteenth century the average longevity in Geneva was 21.21 years; between 1814 and 1833 it was 40.68, and as large a proportion now live to 70 as lived to 43 three hundred years ago. In 1693 the British Government borrowed money by selling annuities on lives from infancy upward, on the basis of the average longevity. The treasury received the price and paid the annuities regularly as long as the annuitants lived. The contract was mutually satisfactory and profitable. Ninety-seven years later Mr. Pitt issued another tontine or scale of annuities, on the basis of the same expectation of life as in the previous century. These latter annuitants, however, lived so much longer than their predecessors, that it proved to be a very costly loan for the Government. It was found that while 10,000 of each sex in the first tontine died under the age of 28, only 5,772 males, and 6,416 females in the second tontine died at the same age one hundred years later. The average life of the annuitants of 1693 was 26.5 years, while those of 1790 lived 33 years and 9 months after they were 30 years old.

From these facts, says Dr. Jarvis, it is plain that life, in many forms and manifestations, and probably in all, can be expanded in vigor, intensity, and duration, under favorable influences. For this purpose it is only necessary that the circumstances amid which, and the conditions in which, any form of life is placed, should be brought into harmony with the law appointed for its being. By this means the intelligent world

has been and is now continually adding to the vitality of the vegetable and animal kingdom, as far as they are brought under their control. Man has increased his own life also, in so far as he has conformed his self-management to the requirements of the vital law.

**Fossil Edentates.**—Prof. O. C. Marsh, in the current number of the *American Journal of Science*, describes some new fossil mammals, being edentates of a stupendous size. They go back very much farther, geologically, than any American species previously described. Some of them are from the Upper Eocene of Wyoming Territory.

## NOTES.

A CONSIDERABLE trade is now carried on between Australia and San Francisco in kangaroo-skins. At the latter place they are much in vogue, and when tanned are said to produce a thin, supple leather, softer than calf-skin and more impervious to water.

DR. T. C. RENNER writes to the Department of Agriculture, that several years ago he collected some poke-root (*Phytolacca decandra*) for medicinal purposes, and spread it at several places about the house to dry. Soon afterward he observed that there were many cockroaches lying dead, and upon examination found that they had been partaking freely of the poke-root. Some of the root was placed near their haunts, and the result was that it rid the premises of those insects. Since then he has communicated the remedy to others, who have tested it with satisfactory results.

THE Italian Government having invited Father Secchi, S. J., to remain at his post, he declined to do so unless the pope's rights over the observatory were recognized. The Government has acceded to his request, and is walling off from the rest of the expropriated Collegio Romano the portion comprising the observatory, in which Father Secchi and his assistants are to remain undisturbed.

THE first oil-field around Titusville, Pa., appears to be again becoming productive. Territory long since abandoned and deemed worthless promises to give as abundant a yield of oil as any in the whole oil-region. Several wells recently sunk in the territory yield from 100 to 500 barrels per day.

BENJAMIN THOMPSON, afterward Count Rumford, was born in Woburn, Mass., and not, as might be inferred from a paragraph in the April MONTHLY, in Concord, N. H.

ABOUT the year 1300 coal was first discovered in England on the banks of the Tyne, and was introduced as fuel into London about the year 1350. Its use, however, was in 1373 forbidden by proclamation, in consequence of its effluvia being considered injurious to health, by corrupting the atmosphere, and for many years it remained unused. At the close of the century, however, the value of coal became recognized, and its application and consumption extended.

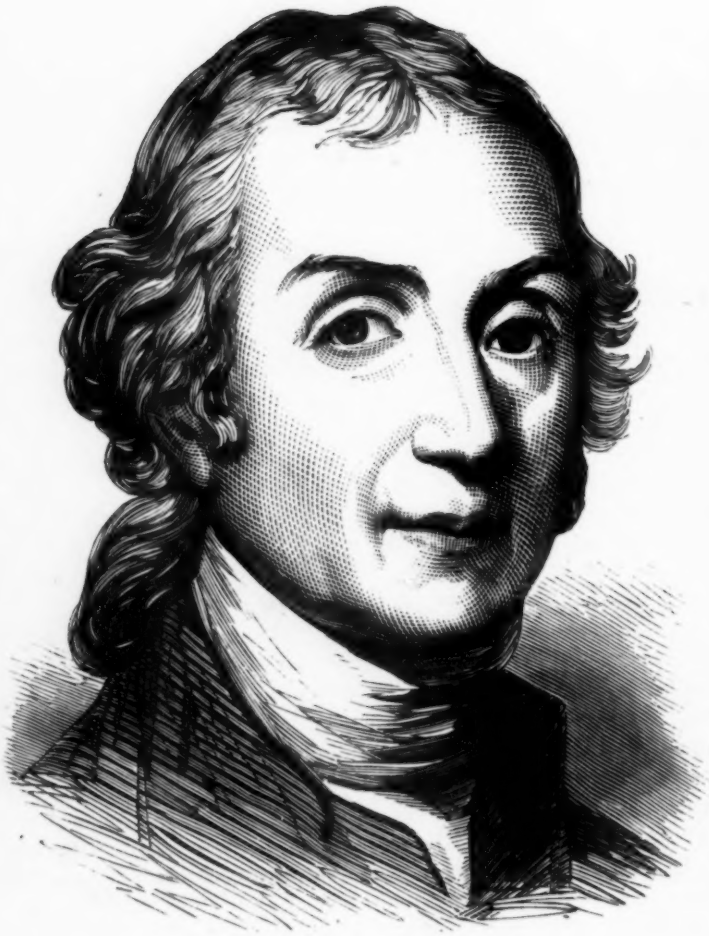
POGGENDORFF'S *Annals of Physics and Chemistry*, a monthly periodical, has now been in existence fifty years, and has been under the sole editorial direction of Prof. Poggendorff for that long period. Some of the friends of the venerable editor have agreed to assume editorial charge of the work for one volume, thus allowing the veteran a four months' vacation. The entire number of papers published in the *Annalen*, during the fifty years of its existence, is 8,850, and among the 2,167 authors who have contributed to its pages are Liebig, Berzelius, Faraday, Brewster, Becquerel, and many others.

THE French Assembly have voted a pension of 12,000 francs to M. Pasteur for his eminent services to science, more particularly for his researches into the causes of the diseases of the vine and the silk-worm.

THE *American Naturalist* calls for a careful geological and zoological survey of Massachusetts. While surveys are going on or have recently been completed in so many other States, it is not particularly to the credit of Massachusetts that a thorough survey of its geological and biological riches has been neglected It is now over thirty years since the original incomplete survey of the State was made. Since then physical science has changed so much that the work done then needs to be reviewed and greatly extended.

DIED, in Charleston, S. C., February 28th, Rev. John Bachman, aged eighty-four years. He was associated with Audubon in the preparation of his great work on ornithology, and was the principal author of the work on the quadrupeds of North America, illustrated by Audubon and his sons. He was also the author of numerous other works and papers on zoological subjects, all evincing superior powers of observation, and marked by excellence of statement.

PETER ANDREAS HANSEN, Director of the Observatory of Seeberg, near Gotha, died on the 28th of March last, aged seventy-nine years. He is chiefly famous for his elaborate investigation of the moon's motion, and the tables constructed on the basis of his theoretical labors. These tables were published in London, in 1857, at the expense of the British Government.



Dr. JOSEPH PRIESTLEY.